PUBLICATION NO. 980480

PRELIMINARY

9000

MICROPROCESSING TIMER/COUNTER

DANA LABORATORIES, INC.
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IRVINE, CALIFORNIA 92664

DANA®

TELEPHONE (714) 833-1234
TELEX 678-341
TELETYPE 910-595-1136

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WARRANTY

Within one year of purchase, Dana Laboratories will repair or replace your instrument, at our option, if in any way it is defective in material or workmanship. All parts and labor charges will be paid by Dana Laboratories. Just call Dana Product Service at (714)833-1234 collect in California, for assistance. We will advise the proper shipping address for your prepaid shipment. Your instrument will be returned to you freight prepaid.

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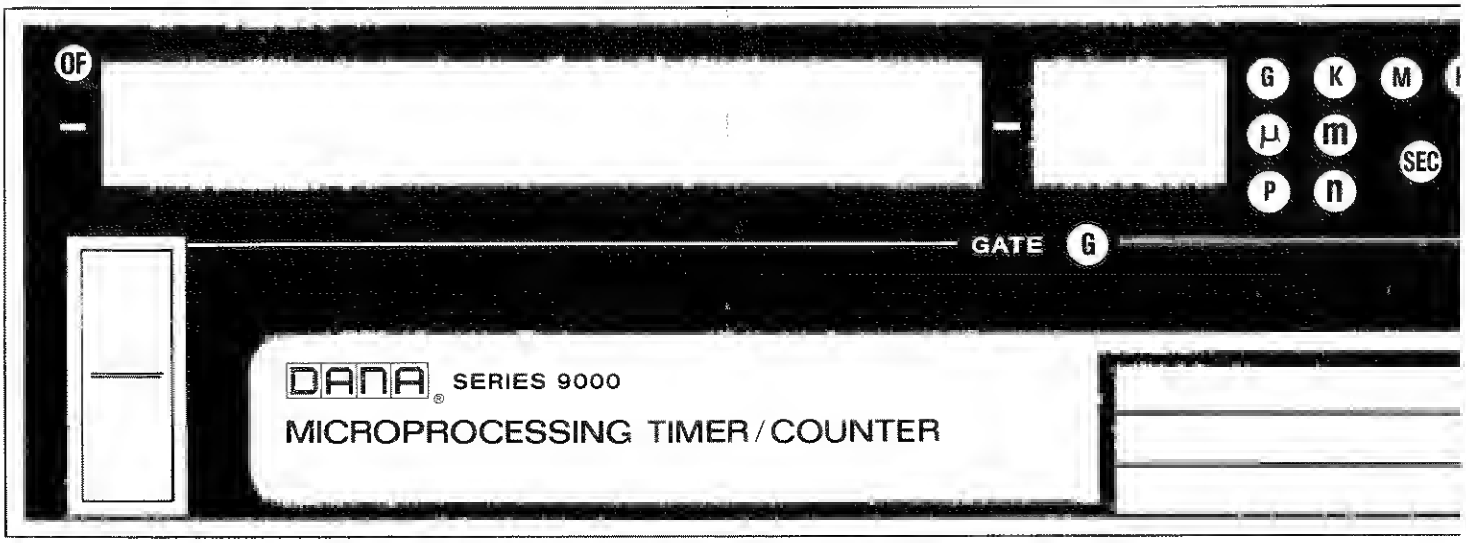


Figure 1.1 - Series 9000 Microprocessing Timer/Counter

SECTION 1 GENERAL DESCRIPTION

1.1 GENERAL.

1.1.1 This manual covers the installation, operation and calibration of the Dana Series 9000 Microprocessor Timer/Counter (figure 1.1).

1.1.2 The 9000 Series consists of two models: the 9015 and the 9035. The Model 9035 performs all of the functions of the 9015 and, in addition, measures frequencies from 100 MHz to 512 MHz. A condensed table of measurement modes is given in table 1.1.

1.2 GENERAL DESCRIPTION.

1.2.1 The Series 9000 features universal counter measurement modes, computation capabilities, keyboard entry, 9-digit display, a full complement of annunciators, and manual and automatic trigger level setting.

1.2.1.1 Standard measurement modes include Time Interval, Time Interval Average, Period, Period Average, Frequency Ratio, Totalizing, Scaling, Frequency A measurements from 0 to 100 MHz and, on the Model 9035, Frequency C measurements of from 100 MHz to 512 MHz.

1.2.1.2 The calculating capabilities include addition of a constant to a measurement, the subtraction of a constant from a measurement, multiplication of a measurement by a constant, division of a measurement by a constant, and the reciprocal of a measurement. The constant used in the computation can be any number of either polarity from 1 to 9 digits long with exponent notation from 1 to 99 of either polarity.

1.2.1.3 The keyboard consists of 32 pushbuttons and six slide switches on a drawer that slides into the front of the instrument when not in use. All local control functions except power is through the keyboard including function, timebase, slope, coupling, sep/com, test, auto and manual trigger level, norm/hold, arithmetic entry, reset, initialize, start/stop and remote.

1.2.1.4 The front panel contains the standard input BNC connectors, the power switch, and all of the visual indicators including the display, gate time/multiplier, annunciators and trigger levels. The display provides 9 digit resolution of measurement with fixed decimal and leading and following zero blanking. The display is used for both measurement and arithmetic computation. The display consists of an overflow indicator, a "–" polarity sign, 9 numeric display LEDs, an exponent-polarity sign and 2 numeric exponent LEDs. The display scale consists of a nine LED annunciator indicating the time or frequency or events of the measurement. The function annunciator consists of seven LEDs which indicate the function selected. The gate time/multiplier is a single numeric LED with a "." polarity indicator and a seconds indicator. The numeric LED signifies the power to which 10 is raised and represents the setting of the timebase/multiplier. The status of the channel A and channel B triggers are shown including the range, coupling, slope, trigger level (3 digits), trigger level polarity and channel A/B common coupling. Other annunciators on the front panel include remote, external reference, in-range (functional on 9035 only), and gate.

1.2.2 Options available for the Series 9000 offer increased flexibility for the user in the areas of pulse measurement, accuracy, and systems use with the pulse parameter option, two oscillator options, four interface options, and mounting and rear input options. These are described briefly below.

1.2.2.1 *Option 11 Pulse Parameter.* This option provides automatic measurement of rise time from 10% to 90% points, fall time from 90% to 10% points and positive pulse width at 50% of peak points. All pulse measurements are made in the Time Interval or Time Interval Average modes. This option replaces the arithmetic computation controls except reciprocal.

1.2.2.2 *Option 01 Rear Input.* This option consists of three input connectors provided at the rear panel and the internal movement of the signal conditioning boards to new

Table 1.1 - Measurement Capability

Model	Time Interval	Time Interval Averaging	Period	Period Average	Freq A (to 100 MHz)	Freq C (to 512 MHz)	A/B Ratio	Totalize
9015	X	X	X	X	X		X	X
9035	X	X	X	X	X	X	X	X

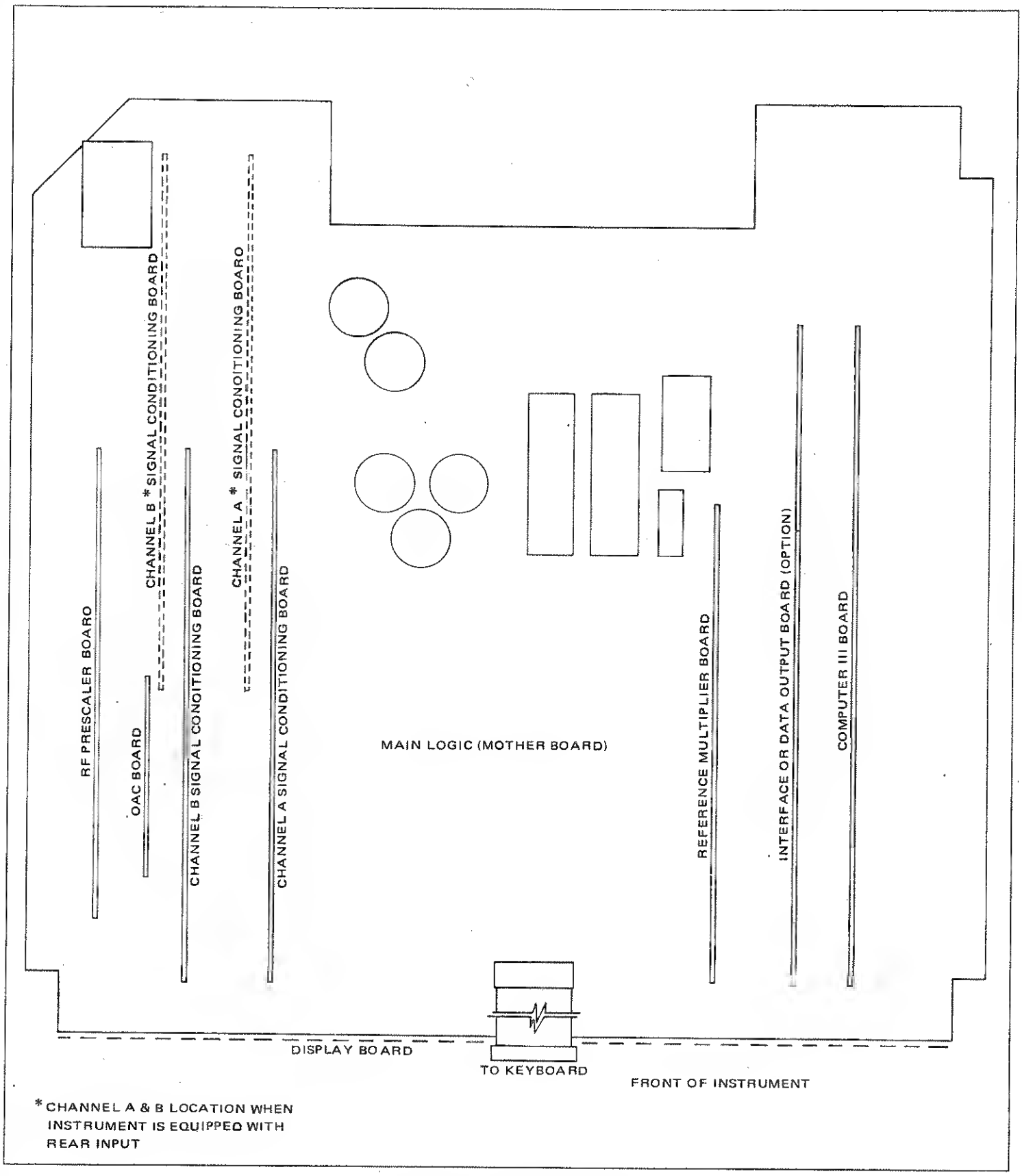


Figure 1.2 - Plug-In Board Locations

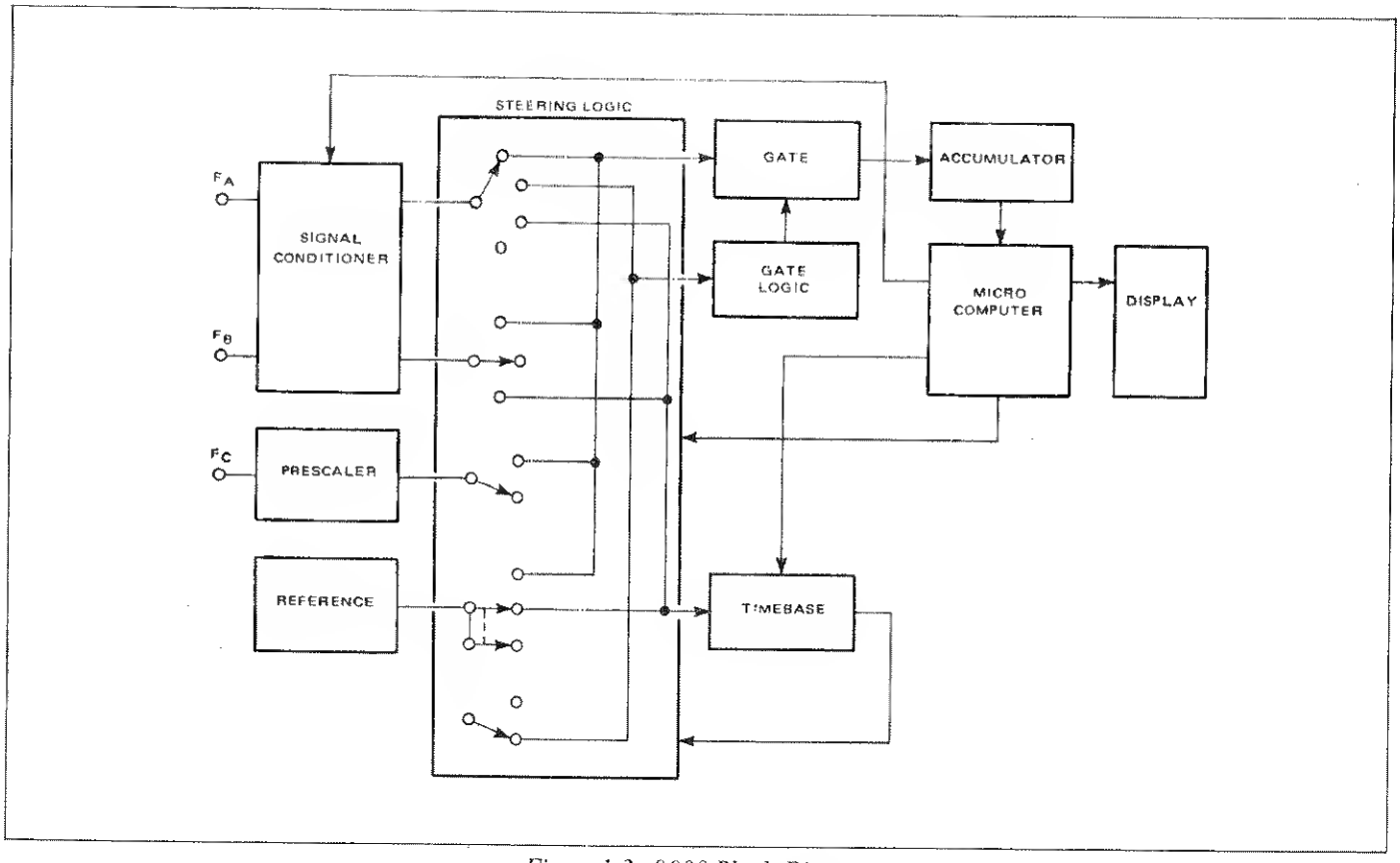


Figure 1.3 - 9000 Block Diagram

rear input connector locations. The option is primarily for systems use; the front panel connectors being open. The instrument is converted back to a hench top instrument by placing the signal conditioning boards back to the front panel input locations.

1.2.2.3 *Option 22 Oven Oscillator.* This option replaces the standard internal reference and provides an aging rate of $<1x10^{-9}$ per day.

1.2.2.4 *Option 24 Oven Oscillator.* Same as option 22 but with an aging rate of $<5x10^{-10}$ per day.

1.2.2.5 *Option 51 Parallel BCD Output.* This option provides all front panel display data in electrical BCD TTL compatible form for use by a printer or other digitally operated device.

1.2.2.6 *Option 55 Parallel ASCII GPIB Interface.* This option is directly compatible with the IEEE General Purpose Interface Bus and permits direct communication between the 9000 and a controller for both programming and data output.

1.2.2.7 *Option 56 High Speed Computer Interface.* This option is used generally in systems utilizing a computer and permits selection of two speeds; computer speed in which raw data is transmitted by the 9000 and microprocessor speed which allows the data to be manipulated by the microprocessor. Four bus formats allow the user to customize the 9000 interface to fit a particular system.

1.2.2.8 *Option 57 Serial ASCII Interface.* This option is designed for use with and permits a two way dialog between a serial ASCII keyboard. As many as 10 instruments can be operated on one bus.

1.2.2.9 *Option 60 Rack Mounting Flanges.* This option allows the 9000 to be mounted in a standard 19-inch raek.

1.3 MECHANICAL DESCRIPTION.

1.3.1 The Model 9000 is completely enclosed in a standard rack width, aluminum case and is designed for either rack or beneh top operation.

1.3.2 The standard instrument (figure 1.2) consists of the mainframe (mother board) with five plug-in boards and the display board. The mainframe is mounted next to the top cover of the instrument with the component side of the board facing down. On the board is mounted most of the logic components, the reference oscillator and the power

supply. The plug-in boards plug into the mainframe and are between the mainframe and the bottom cover. The plug-in boards are the DAC board, channel A Signal Conditioning board, the channel B Signal Conditioning board, the Reference Multiplier, and the Computer III board. (Instruments designed to meet the special requirements of a customer may have three boards in place of the Computer III board.)

1.4 ELECTRICAL DESCRIPTION.

1.4.1 The Model 9000, shown in simplified form in figure 1.3, consists of the following functional blocks: Signal Conditioning circuitry that scales, generates a squared wave output from the input signal, and selects the points on the incoming signal that determine the characteristics of the squared wave output; a stable and accurate 100 MHz reference frequency; an adjustable timebase that allows the signal applied to it to be divided by 1, 10, or some multiple of 10; gate logic that converts a signal input into a corresponding time period; a gate (controlled by the gate logic) that regulates the flow of pulses to the accumulator; an accumulator that counts a signal applied to it and stores the binary value of the count; a microcomputer that controls the operation of the counter, performs any programmed arithmetic operations, and routes the data in the accumulator to the display; the display that provides in visual form the numeric value of the binary data stored in the accumulator as well as the status of the timebase, signal conditioners and other instrument operations.

1.4.2 The instrument performs the various measurement functions by routing the input signal and internal signals, according to the function and timebase division selected, between the various functional blocks. Mathematical operations are performed by routing the data from the accumulator to the microcomputer. All computations then take place within the microcomputer and the results routed to the display.

1.5 MISCELLANEOUS.

1.5.1 Items Furnished.

1.5.1.1 Items provided with the Series 9000 includes:

a. Power Cable.

b. Operators Manual.

1.5.2 Required Tools & Test Equipment.

1.5.2.1 Tools required for maintenance are listed in paragraph 5.7.1.1.

1.5.2.2 Equipment required for calibration is shown in table 5.1.

1.6 SPECIFICATIONS.

1.6.1 The specifications are shown in table 1.2.

Table 1.2 - Specifications

GENERAL	
Calculating Capability:	ADD or SUBTRACT a constant from the measurement; MULTIPLY and DIVIDE the measurement by a constant reciprocal of a measurement.
Memory Capability:	The constant operates on successive measurements until either the measurement mode is changed or the constant/ operation is changed, or the unit is reinitialized.
Constant Range:	±999.999999 EXP ±99
Automatic Ranging:	Channels A and B voltage ranges are automatically selected as a function of the input signals' voltage levels.
Manual Ranging:	Channels A and B voltage ranges are selected as a function of the trigger level resolution.
Automatic Trigger Level:	The counter measures the maximum and minimum peak of the input signal, calculates the arithmetic mean, and automatically sets the trigger level at the mean. Standard on both channels A and B. For inputs ≥ 400 Hz, ≥ 50 mV RMS.
Internal Reference Oscillator:	
Aging Rate:	$<3\times10^{-7}$ per month
Temperature Stability:	$<5\times10^{-6}$, 0°C to +50°C
Voltage Stability:	$<1\times10^{-7}$ with 10% line voltage variation
Internal Reference Output:	10 MHz square wave, buffered, TTL compatible

Table 1.2 - Specifications continued

GENERAL continued	
External Reference Input:	1, 5, or 10 MHz; 1V RMS into 1 Kohm. Counter automatically locks to external reference; if present, front panel indicator lights.
Marker Output:	Negative-going pulse, 14 volt amplitude, rear BNC, duration equal to channel A trigger point to channel B trigger point.
Display:	
Numeric:	Eleven, 11 mm (.43 inch) yellow LEDs. Leading and following zeros suppressed.
Status Indicators:	LED lamps show status of counter controls: Function, Measurement Time, System Control, External Reference, Input voltage range, Slope, Coupling, Separate/Common, and Test. LED lamps show numeric readout dimensional units, overflow, condition, and channel C input status.
Trigger Level:	Two, 3-digit 2.8 mm (.11 inch) red LEDs.
Sample Rate:	Periodic or hold, switch selectable. In periodic mode, rest time between readings is approximately 300 msec.
Input/Output Connectors:	BNC
Operating Temperature:	0°C to +50°C
Storage Temperatures:	−20°C to +70°C at 75% RH
Operating Humidity:	< 75% RH from +25°C to +40°C <50% RH from +40°C to +50°C
Dimensions: (HxWxD)	3-15/32 x 16-3/4 x 18 inches
Weight:	Net 19 lbs. (8.6 Kg) Shipping 25 lbs. (11.4 Kg)
Power Requirement:	100/120/220/240V RMS, +5%, −10%, 50-60 Hz 125 Watts, maximum

INPUT CHARACTERISTICS	
Channel A and B Frequency Range:	
DC Coupled:	0 to 100 MHz
AC Coupled:	20 Hz to 100 MHz
Coupling:	DC or AC, switch selectable
Sensitivity Sinewave:	25 mV RMS to 1 MHz 50 mV RMS to 50 MHz 100 mV RMS to 100 MHz
Pulse:	150 mV P-P; 8 nsec minimum width
Input Impedance:	1 Mohm shunted by less than 25 pF.
Maximum Input: (without damage)	250V RMS or 300V peak on all ranges. On 1V range, degrade by 20 dB/decade above 1 MHz to 2.5V RMS at 100 MHz.
Voltage Ranges:	1, 10, 100; Keyboard selectable or automatically selected.
Trigger Level:	Digitally adjustable (keyboard entry) from +318.75% to −320% of voltage range. Digital levels displayed on front panel and analog levels (DAC outputs) available on rear panel.
Input Trigger Level Accuracy:	±5% of range ±0.1% range per °C
Output Trigger Level Accuracy:	±2% of range of actual trigger point
Channel C (Model 9035 only) Frequency Range:	100 MHz to 512 MHz
Sensitivity Sinewave:	15 mV RMS
Input Impedance:	50 Ohms nominal
Maximum Operating Input:	1V RMS
Maximum Input: (without damage)	5V RMS (fuse protected)
Automatic Gain Control:	40 dB without adjustment
Prescale Factor:	10

Table 1.2 - Specifications continued

TIME INTERVAL MEASUREMENT	
Range:	10 nsec to 10^9 seconds
Resolution:	10 nseconds
Accuracy:	±1 count ± reference error ± trigger error*
Input:	
Separate Mode:	Channel A start and Channel B stop
Common Mode:	Channel A start and stop
Home State:	
Resolution:	10 nsec
Reciprocal Mode (1/X):	Displays $\frac{1}{\text{Time Interval}}$
Display:	nsec, μsec, msec, sec, ksec, or Msec
*trigger error $\frac{\leq 0.0025\ \mu\text{sec}}{\text{Signal Slope (in V/}\mu\text{sec)}}$	

TIME INTERVAL AVERAGE	
Range:	100 psec to 1 sec
Accuracy:	±reference error ± 2 nsec ± $\frac{\text{(trigger error* + 10 nsec)}}{\sqrt{\text{Number of Intervals Averaged}}}$
Intervals Averaged:	10 to 10^9, selectable in decade steps
Dead Time:	Minimum time between stop and start: 50 nsec
Input:	
Separate Mode:	Channel A start and Channel B stop
Common Mode:	Channel A start and stop
Home State:	
No. Intervals Averaged:	'10'
Resolution:	1 nsec
Reciprocal Mode (1/X):	Displays $\frac{1}{\text{Time Interval Average}}$
Display:	psec, nsec, μsec, msec, or sec
*trigger error $\frac{\leq 0.0025\ \mu\text{sec}}{\text{Signal slope (in V/}\mu\text{sec)}}$	

PERIOD MEASUREMENT	
Range:	10 nsec to 10^9
Resolution:	10 nsec
Accuracy:	±1 count ± reference error ± trigger error*
Input:	Channel A
Home State:	
Resolution:	10 nsec
Reciprocal Mode (1/X):	Displays Frequency, 1 Hz to 100 MHz
Display:	nsec, μsec, msec, sec, ksec, or Msec
*trigger error $\frac{\leq 0.3}{(S/N)\ f_A}$	
where S/N equals signal to noise ratio in volts and f_A equals input frequency	

PERIOD AVERAGE	
Range:	10 nsec to 1 sec
Accuracy:	±reference error ± 1 count ± $\frac{\text{trigger error*}}{\text{Number of Periods Averaged}}$
Intervals Averaged:	1 to 10^8, selectable in decade steps
Input:	Channel A
Home State:	
No. Intervals Averaged:	'10'
Resolution:	1 nsec
Reciprocal Mode (1/X):	Displays frequency, 1 Hz to 100 MHz
Display:	nsec, μsec, msec, or sec
*trigger error $\frac{\leq 0.3}{S/N\ f_A}$	
where S/N equals signal to noise ratio in volts and f_A equals input frequency	

Table 1.2 - Specifications continued

FREQUENCY MEASUREMENT TO 100 MHz	
Frequency Range:	
DC Coupled:	0 to 100 MHz
AC Coupled:	20 Hz to 100 MHz
Accuracy:	
Standard Mode:	±1 count ± reference error
Computing Mode:	$\frac{1}{\text{Accuracy of Period Meas'mt}}$
Input:	Channel A
Measurement:	
Standard Mode:	1 μsec to 10 sec, selectable in decade steps
Home State:	
Measurement Time:	.1 sec
Frequency Resolution:	10 Hz
Reciprocal Mode (1/X):	Displays Period, 10 nsec to 10^6 sec
Display:	9 digits; mHz, Hz, kHz, or MHz
Self Test: (10^{-1} sec timebase):	10.00000 MHz

FREQUENCY MEASUREMENT TO 512 MHz (Model 9035 Only)	
Frequency Range:	100 MHz to 512 MHz
Accuracy:	±1 count ± reference error
Input:	Channel C
Measurement Time:	1 μsec to 10 sec, selectable in decade steps
Home State:	
Measurement Time:	.1 sec
Frequency Resolution:	100 Hz
Reciprocal Mode (1/X):	Displays Period, 2 nsec to .1 μsec
Display:	9 digits, MHz

FREQUENCY RATIO MEASUREMENTS	
Frequency Range:	
Channel A:	0 to 100 MHz
Channel B:	0 to 100 MHz
Ratio:	10^{-8} to 10^8
Multiplier:	f_B scaled by 1 to 10^9, selectable in decade steps
Accuracy:	±1 count of f_A ± trigger error* of f_B
Home State: Multiplier:	10
Reciprocal Mode (1/X):	Displays multiplier $f_B \div f_A$,
Display:	$f_A \div$ multiplier f_B, dimensionless
*trigger error $\frac{\leq 0.0025\ \mu\text{sec}}{\text{Signal slope (in V/}\mu\text{sec)}}$	

TOTALIZE MEASUREMENT	
Frequency Range:	0 to 100 MHz
Count Range:	0 to 10^9
Accuracy:	±1 count per gate

SCALING	
Frequency Range:	0 to 100 MHz
Scaling Range:	
≤10 MHz:	1 to 10^9, selectable in decade steps
> 10 MHz:	10 to 10^9, selectable in decade steps
Input:	Channel C

Table 1.2 - Specifications continued

PULSE PARAMETER MEASUREMENTS (Option 11)	
Initiation of the required measurement by a single key entry activates the microprocessor to measure the pulse amplitude, calculate and set the required start/stop trigger level settings, and initiate the counter to take the time interval measurement. The start and stop trigger level values are displayed on the front panel and are available to the system output.	
Rise Time:	
Start Point:	10% of pulse amplitude, positive slope
Stop Point:	90% of pulse amplitude, positive slope
Fall Time:	
Start Point:	90% of pulse amplitude, negative slope
Stop Point:	10% of pulse amplitude, negative slope
Pulse Width:	
Start Point:	50% of pulse amplitude, positive slope
Stop Point:	50% of pulse amplitude, positive slope
Range:	
Single Measurement:	10 nsec to 10^9 sec
Multiple Intervals Measurement:	100 psec to 1 sec
Intervals Averaged:	1 to 10^9, selectable in decade steps
Time Measurement Accuracy:	
Single Measurement:	$\pm$1 count $\pm$ reference error $\pm$ trigger error*
Multiple Intervals Measurement:	$\pm$reference error $\pm$ 2 nsec $\pm$ $\frac{\text{(trigger error* + 10 nsec)}}{\sqrt{\text{Number of Intervals Averaged}}}$
Trigger Level Setting Accuracy:	$\pm$5% of voltage range
Input:	Channel A
Minimum Pulse Height:	0.3V
Display:	nsec, μsec, msec, sec, ksec, or Msec
*Trigger error $\frac{\leq 0.0025\ \mu\text{sec}}{\text{Signal slope (in V/}\mu\text{sec)}}$	

INTERNAL REFERENCE OSCILLATOR OPTIONS	
Option 22	
Aging Rate:	$<1\times10^{-9}$ per day
Temperature Stability:	$<5\times10^{-9}$, 0°C to +50°C
Voltage Stability:	$<2\times10^{-9}$ with 10% line voltage variation
Option 24	
Aging Rate:	$<5\times10^{-10}$ per day
Temperature Stability:	$<5\times10^{-9}$, 0°C to +50°C
Voltage Stability:	$<2\times10^{-9}$ with 10% line voltage variation
Warmup*:	72 hours

*Time to reach aging specification after 24 hours off.

SECTION 2 INSTALLATION & OPERATION

2.1 GENERAL.

2.1.1 This section covers the unpacking, inspection, installation, storage, repacking, and operation of the Series 9000 Counter.

2.1.2 The Operation section consists of brief descriptions of the front and rear panels, and the keyboard. This is followed by a series of tables that provide setup information and typical measurement examples.

2.2 UNPACKING AND INSPECTION.

2.2.1 The Series 9000 counter is packed in a plastic-foam form within a cardboard carton for shipment. The plastic form holds the counter securely in the carton and absorbs any reasonable external shock normally encountered in transit.

2.2.2 Prior to unpacking, examine the exterior of the shipping carton for any signs of damage. Carefully remove the counter from the carton and inspect the exterior of the instrument for any signs of damage. If damage is found, notify the carrier immediately.

2.3 BENCH OPERATION.

2.3.1 Each counter is equipped with a tilt bail or "kickstand" to enable the front of the instrument to be elevated for convenient bench use. The tilt bail is attached to the two front supporting "feet" at the bottom of the instrument. For use, the bail is pulled down to its supporting position.

2.3.2 The controls of the instrument are located on a keyboard which fits inside the instrument at the front panel when not in use. The keyboard pulls out when control entries are to be made and is hinged to allow the keyboard to slope down to the bench level for easy operation.

2.4 RACK MOUNTING.

2.4.1 The instrument can be mounted in a standard 19-inch rack with the option 60 rack-mounting flanges. To install the flanges, proceed as follows:

a. With instrument on its side, loosen the four captive Phillips head screws holding the bottom cover and remove cover. Remove screws holding feet (and bail) in place. Replace bottom cover.

b. Place one of the supplied screws through each of the two holes in the mounting flange (figure 2.1). Thread a securing nut onto each screw just enough to attach it to the screw (approximately one turn).

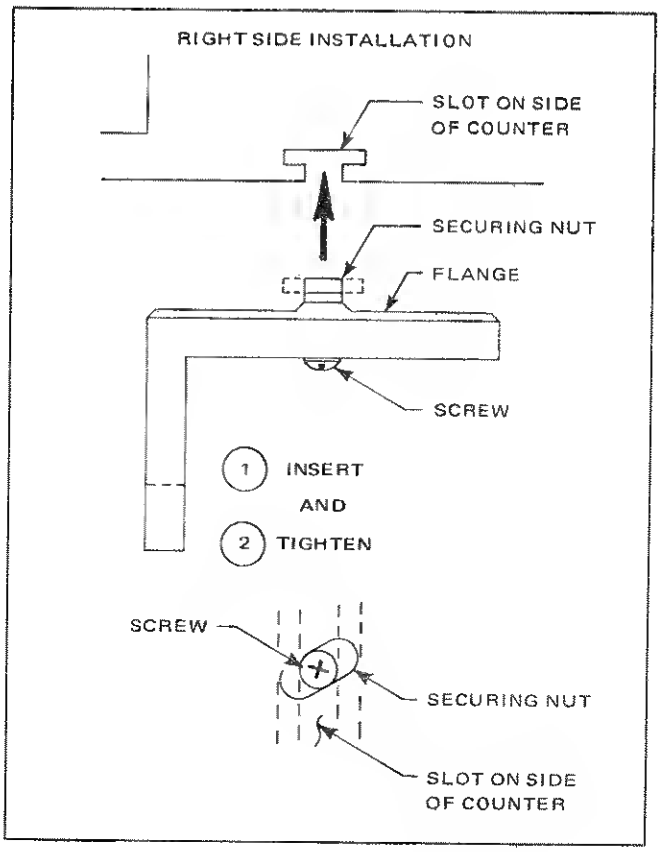


Figure 2.1 - Rack Mount Installation

c. Place the mounting flange onto the mounting slot in the instrument side panel so that the securing nuts fit entirely into the slot. Be sure the rack-mount slots on the flange are toward the front of the instrument.

d. Tighten screws. The securing nuts will rotate and hold the flange securely in place.

2.5 POWER CONNECTIONS.

2.5.1 Power is supplied to the counter through a standard 6-foot long detachable power cord. The ground pin (round) on the power plug is electrically connected to the case of the counter. It is important that this pin be connected to a good quality earth ground.

2.5.2 The cord connects to the power connector module located on the rear panel which incorporates a fuse holder and power line voltage level selector. An additional line selector is internally located in instruments equipped with option 22 or 24 (see paragraph 2.5.5).

2.5.3 The fuse holder and power selector are accessible only when the power cable is removed. The power fuse is ejected by a lever marked FUSE PULL. The instrument uses a 1-1/4 amp fuse for 100 and 120 volt operation and a 3/4 amp fuse for 220 and 240 volt operation.

2.5.4 The instrument is made compatible with the available line voltage by the position of a small printed circuit board that fits into a slot in the module below the fuse. The board can be inserted into the slot in any one of four ways to provide for operation on the four available line voltage levels. The instrument is compatible with line frequencies from 48 to 440 Hz.

2.5.5 Instruments equipped with the option 22 or option 24 high stability reference oscillator have included an additional power supply. This supply provides power to the option as long as the power cord is connected, regardless of the position of the front panel power switch. The supply, located at J10 on the mainframe, has a line select switch which must be set to correspond to the line voltage. Access to the switch is gained by loosening the four captive corner screws and removing the bottom cover.

2.6 GROUNDING REQUIREMENTS.

2.6.1 To protect equipment operators from possible injury in the event of shorts or fault currents, the front panel and case of this instrument are grounded in accordance with MIL-T-28800A. A low impedance ground is maintained through one conductor of the three conductor power cable supplied with the instrument, when the cable is plugged into an appropriate, properly wired, receptacle.

2.7 STORAGE REQUIREMENTS.

2.7.1 The instrument can be stored at temperatures ranging from $-20^{o}C$ to $+70^{o}C$ at 75% relative humidity without adversely affecting operation or accuracy. The instrument must be brought up to within the specified operating range ($0^{o}C$ to $+50^{o}C$) before power is applied.

2.8 RESHIPMENT PACKAGING REQUIREMENTS.

2.8.1 The shipping carton with its molded plastic foam forms and plastic dust cover is specifically designed to provide the required support necessary for safe shipment. Whenever possible, these should be used for reshipment.

2.8.2 If the original packing materials are not available, proceed as follows:

a. Wrap instrument in plastic or heavy paper.

b. Place packing material around all sides of instrument and pack in cardboard box.

c. Place instrument and inner container in sturdy cardboard or wooden box. Mark box with appropriate precautionary labels.

2.9 INPUTS, OUTPUTS, & CONTROLS.

2.9.1 Front Panel.

2.9.1.1 On the front panel are located all of the visual indicators, the power switch, and the standard signal input connectors. The following paragraphs describe in brief the operation of each.

2.9.1.1.1 *Power Switch.* The power switch is a toggle switch with a built-in lamp that lights when the switch is on. The switch controls all power to the instrument.

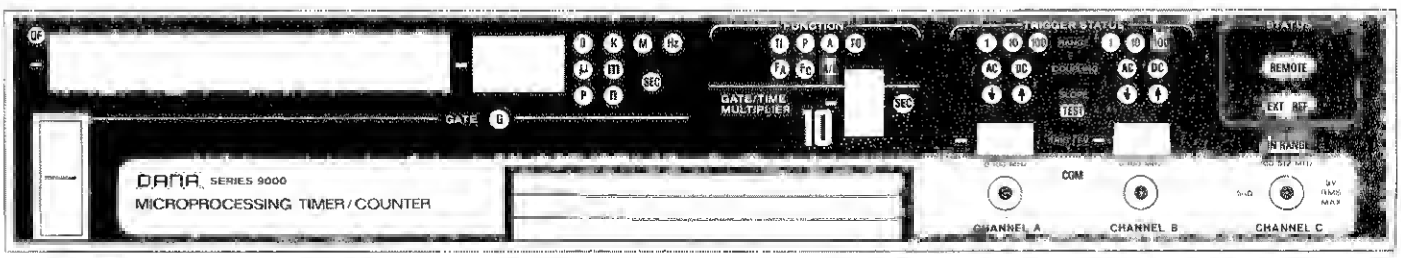
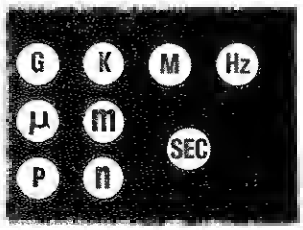


Figure 2.2 - Front Panel

2.9.1.1.2 *Display.* The display consists of 9 numeric LED digits, an overflow indicator, and a "–" polarity indicator. The display features fix decimal and leading and following zero blanking. It is used to display measurements, arithmetic entries, and the results of arithmetic operations. The overflow lights when the measured reading exceeds 999,999999.

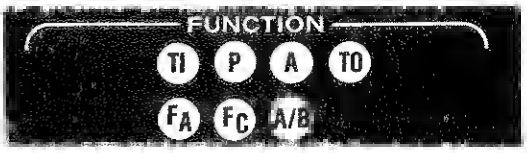
2.9.1.1.3 *Exponent.* The exponent consists of 2 numeric LED digits and a "–" polarity indicator. For arithmetic computation, it can be used to indicate the exponent of an entry and the resultant; for standard function measurements it can be used as an extension of the display for added resolution.

2.9.1.1.4 *Measurement Units.* The units consists of a 9 LED annunciator that indicates the timescale or frequency



scale of the display. The unit selected is dependent on the Function and Gate Time/Multiplier selected.

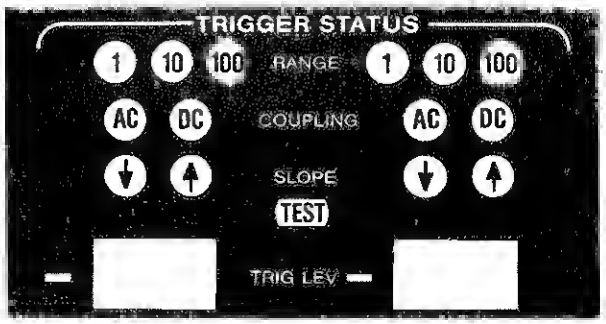
2.9.1.1.5 *Function.* The function consists of a 7 LED annunciator that indicates the function selected.



2.9.1.1.6 *Gate Time/Multiplier.* The gate time/multiplier consists of a LED numeric digit, a "–" polarity indicator, and a SEC (second) indicator. The second indicator is lit during measurements of frequency, period, and time interval; the digit indicates gate time and multiplier selections from 10^{-9} to 10^{9}. If a number is entered which is not available for the function selected, the instrument selects the nearest

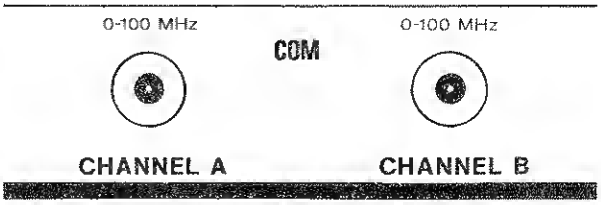
available number and that number is entered and displayed. The effect on the resolution of the display caused by the value of gate time/multiplier selected is shown in table 2.1.

2.9.1.1.7 *Trigger Status.* The trigger status consists of a pair of 3 LED range annunciators, a pair of 2 LED coupling



annunciators, a pair of 2 LED slope annunciators, a TEST indicator, and a pair of 3 numeric LED digit trigger level annunciators with decimal point and "–" polarity indicator. The trigger status indicates the condition of the channel A and channel B input signal conditioners. The coupling, slope, and test indicators light according to switch selection; the range annunciators light according to the value of the trigger level selected (or computed with AUTO selected).

2.9.1.1.8 *Channel A, B Input.* The channel A and B inputs consist of two BNC connectors and a COM (common) indicator. The common indicator lights to indicate that the



common input mode is selected (i.e., the inputs to channel A and B signal conditioners are tied in parallel and fed through the channel A input connector with channel B input connector floating). The specifications on both channels are:

Input Z	=	1 Meg in parallel with <25 pF
RMS Sensitivity	=	25 mV to 1 MHz, 50 mV to 50 MHz, 100 mV to 100 MHz
Freq Range	=	DC coupled 0 – 100 MHz, AC coupled 20 Hz – 100 MHz

Table 2.1 - Gate Time/Multiplier

Timebase	TI Input: 1 Hz	Display Scale	P Input: 1 Hz	Display Scale	F_A Input: 50 MHz	Display Scale
+1					5 0 . 0 0 0 0 0 0 0	M Hz
0			1 .	sec	5 0 . 0 0 0 0 0 0	M Hz
–1	. 5	sec	1 . 0	sec	5 0 . 0 0 0 0 0	M Hz
–2	. 5 0	sec	1 . 0 0	sec	5 0 . 0 0 0 0	M Hz
–3	5 0 0 .	m sec	1 . 0 0 0	sec	5 0 . 0 0 0	M Hz
–4	5 0 0 . 0	m sec	1 . 0 0 0 0	sec	5 0 . 0 0	M Hz
–5	5 0 0 . 0 0	m sec	1 . 0 0 0 0 0	sec	5 0 . 0	M Hz
–6	5 0 0 . 0 0 0	m sec	1 . 0 0 0 0 0 0	sec	5 0 .	M Hz
–7	5 0 0 . 0 0 0 0	m sec	1 . 0 0 0 0 0 0 0	sec		
–8	5 0 0 . 0 0 0 0 0	m sec	1 . 0 0 0 0 0 0 0 0	sec		

Timebase	TIA Input: 1 MHz	Display Scale	PA Input: 2 MHz	Display Scale	A/B Input: 50 MHz
0	. 0 0	μ sec	. 5 0	μ sec	
+1	5 0 0 .	n sec	5 0 0 .	n sec	1 . 0
+2	5 0 0 . 0	n sec	5 0 0 . 0	n sec	1 . 0 0
+3	5 0 0 . 0 0	n sec	5 0 0 . 0 0	n sec	1 . 0 0 0
+4	5 0 0 . 0 0 0	n sec	5 0 0 . 0 0 0	n sec	1 . 0 0 0 0
+5	5 0 0 . 0 0 0 0	n sec	5 0 0 . 0 0 0 0	n sec	1 . 0 0 0 0 0
+6	5 0 0 . 0 0 0 0 0	n sec	5 0 0 . 0 0 0 0 0	n sec	1 . 0 0 0 0 0 0
+7	5 0 0 . 0 0 0 0 0 0	n sec	5 0 0 . 0 0 0 0 0 0	n sec	1 . 0 0 0 0 0 0 0
+8					1 . 0 0 0 0 0 0 0 0

NOTE: Shaded area denotes "Home State".

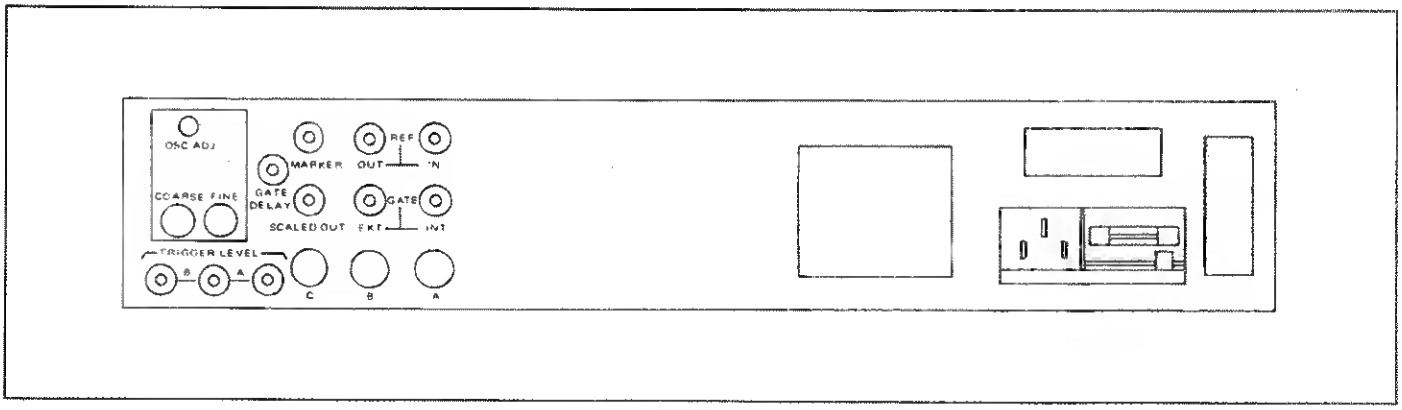
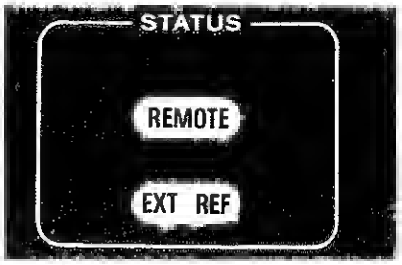


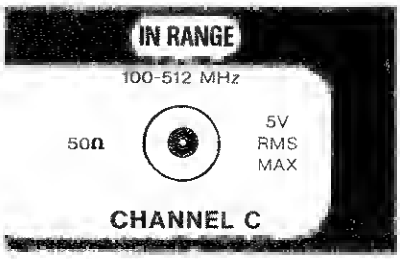
Figure 2.3 - Rear Panel

2.9.1.1.9 *Status.* The status consists of two indicators: REMOTE and EXT REF. Remote is lit whenever remote



operation is selected; EXT REF lights whenever an external reference signal of proper frequency and amplitude is applied to the rear panel EXT REF connector (1, 5, 10MHz; 1V RMS).

2.9.1.1.10 *Channel C Input.* The channel C input consists of a single BNC connector and an IN-RANGE indicator.



The channel C input is used only on the Model 9035 counter. The IN-RANGE lights when an input signal of proper amplitude and of the proper frequency range (100 MHz to 512 MHz, 15 mV to 1 Volt RMS) is applied to the input.

2.9.1.1.11 *Gate.* The gate (G) is an indicator that lights during the gate period to indicate gate operation. Circuitry within the instrument extends the on period of the indicator during short gate times to make viewing possible.

2.9.2 Rear Panel.

2.9.2.1 On the rear panel are located the power line input module and various external control inputs/outputs.

2.9.2.1.1 *Oscillator Adjust.* This is an insulated blade screwdriver adjustment for the standard reference oscillator used in calibration.

2.9.2.1.2 *Coarse, Fine.* These are reference oscillator calibration adjustment points for instruments equipped with either the option 22 or option 24 ultra high stability oven oscillators.

2.9.2.1.3 *Trigger Level.* The trigger level consists of three 5-way binding posts. The center post is common, the post to the left is the channel B trigger level, and the post to the right is the channel A trigger level. The electrical level of the triggers is made available at the rear panel in the event the user desires to monitor these points. The same data is provided on the front panel to three digit accuracy on the front panel and, if the instrument is equipped with any of the interface or the output option, in BCD form at the digital output.

2.9.2.1.4 *Marker.* The marker is a BNC output (+3 to −12V) and is used on the TI and TIA functions in conjunction with an oscilloscope to produce an increase in trace brightness during the period of signal measurement. In this manner the user is provided a visual indicator of the portion of the waveform being measured.

2.9.2.1.5 *Gate Delay.* The gate delay is a BNC connector input that permits the introduction of an external signal to inhibit the closure of the internal gate circuit. This proves particularly useful when desiring to measure the width of a pulse stream.

2.9.2.1.6 *Scaled Out.* The scaled out is a BNC connector output and provides a TTL compatible, scaled squarewave of the TOTALIZE input signal.

2.9.2.1.7 *REF IN.* BNC connector input accepts 1, 5, and 10 MHz signals at 1V RMS. Input impedance is 1 Kilohm.

2.9.2.1.8 *REF OUT.* BNC connector output 10 MHz output squarewave TTL compatible.

2.9.2.1.9 *EXT Gate.* BNC connector output is a TTL compatible buffered gate signal.

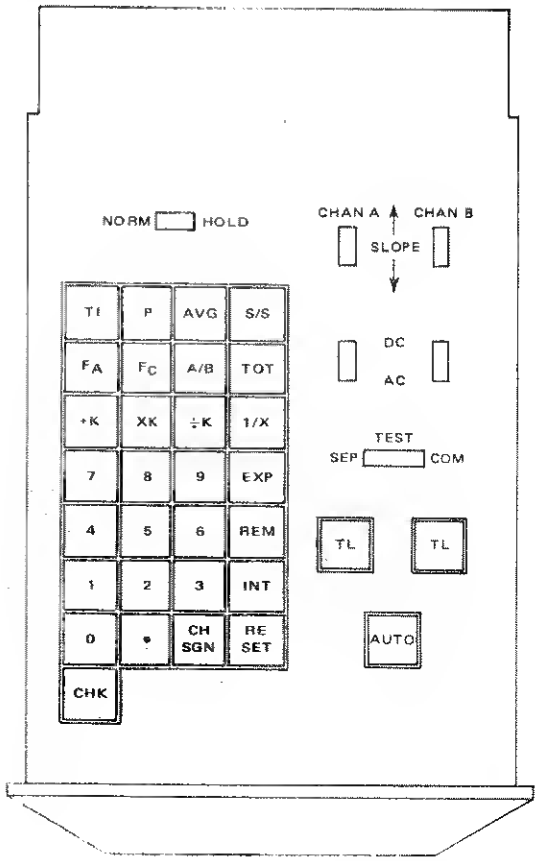
2.9.2.1.10 *INT Gate.* BNC connector input, TTL compatible control for use in TOTALIZE mode.

2.9.2.1.11 *C, B, A.* These are locations for channel inputs on instruments equipped with the option 01 rear input.

2.9.2.1.12 *Power Input Module.* This module contains the power fuse and line voltage selecting board and receives the instrument end of the power cord.

2.9.3 Keyboard.

2.9.3.1 The keyboard consists of a drawer 5x7x.95 inches, with 32 pushbutton switches and six slide switches controlling all instrument operation except power on. The keyboard drawer is located at the lower center of the front panel and extends 7-1/2 inches from the front panel.



2.9.3.2 With the drawer fully extended, a built-in hinge mechanism allows the drawer to swing down providing easy access to the controls for both bench or rack use. When not in use, the drawer slides into the instrument, completely hiding all controls and eliminating the possibility of erroneous commands being entered.

2.9.3.2.1 *Function Keys.* There are eight keys related to the selection or direct operation of the instrument functions. These are TI (time interval), P (periodic), AVG (average, with either TI or P), F_A (frequency A, 0 – 100 MHz), F_C (frequency C, 100 MHz – 512 MHz), A/B (frequency ratio, A input ÷ B input), TOT (totalize), and S/S (start/stop, used with TOT).

2.9.3.2.1.1 By pressing the TI, P, F_A, F_C, A/B, or TOT keys, any of these functions are immediately selected. To select Time Interval Average, the TI key and then the AVG key is selected; similarly to select Period Average, the P key and then the AVG key is selected. The S/S key is used in the Totalize function. To start a reading in Totalize, the S/S key is pushed. The instrument counts pulses applied to the input until the S/S key is again pushed. Pressing the S/S key for a third time begins the count again, continuing from the previous count. To return the count to zero, the RESET key is pressed.

2.9.3.2.2 *Arithmetic Keys* (Standard Instrument). The Arithmetic keys, consisting of the +K, xK, ÷K, and 1/X, are capable of performing any number of computations. The +K algebraically adds an entered number to the display by the following sequence:

Press +K (display goes blank)

enter number to be added (entered number appears in display)

Press +K (sum of original display reading and entered number appears in the display).

NOTE

The number added must be within the range of the number being added to (ex: $2x10^5$ cannot be added to 10. MHz but can be added to 10.0 MHz).

2.9.3.2.2.1 The same procedure is followed for multiplication (xK) and division (÷K).

2.9.3.2.2.2 Pressing the 1/X key takes the reciprocal of the measured data.

2.9.3.3 *Rise/Fall Time Pulse Width (Option 11).* This option permits accurate measurements of 10% to 90% of peak rise times, 90% to 10% of peak full times and automated pulse width measurement at 50% of peak.

2.9.3.4 *Numbers, Decimal, Change Sign, and Exponent Keys.* The numbers (0 through 9), decimal, and change sign keys are used to program the value of the gate time/multiplier and the channel A and channel B trigger levels, and used in arithmetic computations.

2.9.3.4.1 The exponent key is used in arithmetic computation when the user desires to change the operating number to a higher or lower level. The operation is as follows:

Press desired K key

enter number to be entered (number appears in display)

Press EXP key

enter number of exponent to be entered (number appears in exponent readout)

Press the previously selected K key.

2.9.3.4.2 The change sign key is used to change the signs of various portions of the instrument as follows:

a. With a measurement function selected, the CH SGN key selects the polarity of the timebase/multiplier value.

b. With an arithmetic key selected, the CH SGN key selects the polarity of the display data.

c. With the exponent (EXP) selected, the CH SGN key selects the polarity of the exponent.

d. With the channel A trigger level (TL) selected, the CH SGN key selects the polarity of the channel A trigger level.

e. With the channel B trigger level (TL) selected, the CH SGN key selects the polarity of the channel B trigger level.

2.9.3.5 *Remote, Initialize, Reset, and Check Keys.* Pressing the remote key (REM) inhibits all keyboard controls (except Initialize) and puts the instrument in remote control. The instrument can be brought back to local control by pressing the initialize key as long as any controller connected to the instrument has released it.

2.9.3.5.1 The initialize (INT) key causes the instrument to clear all registers, select the Time Interval home state, and sets channels A and B to 100V range and zero trigger levels.

2.9.3.5.2 The RESET key is used to clear the display to zero, reset the internal logic, and initiate a new measurement.

2.9.3.5.3 The check (CHK) is used to check the operation of the numeric LEDs of the display. When selected, all numeric LEDs read 8.

2.9.3.6 *Trigger Level and Auto Keys.* The trigger level keys (TL) allow the user to select the value of the trigger level up to three decimal places for both channel A and channel B. A separate TL key is provided for each channel.

2.9.3.6.1 The trigger level available for each voltage range is ±300%. The voltage range is determined by the position of the decimal point.

Example: Press: channel A TL
Enter: 2.00 (2.00 appears in channel A trigger level display and the channel A "1" range is indicated)
Press: channel A TL (data is entered)

2.9.3.6.2 The AUTO key is used to automatically select the trigger level and range of an incoming signal (for inputs ≥ 400 Hz and ≥ 50 mV RMS).

Example: Press: channel B TL
Press: AUTO (the input signal amplitude is measured, the 50% point of the amplitude is computed and the data is entered).

2.9.4 Slide Switches.

2.9.4.1 *Norm/Hold.* In the NORM position, the instrument operates normally; in the HOLD position the instrument takes one reading and holds the display value indefinitely. New readings can be commanded by using the RESET key.

2.9.4.2 *Slope (A and B).* ↑ selects positive going trigger slope; ↓ selects negative going trigger slope.

2.9.4.3 *Coupling A and B.* DC selects dc coupling; AC selects ac coupling.

2.9.4.4 *SEP/Test/COM.* SEP selects separate inputs (channel A input is routed to channel A signal conditioner; channel B input is routed to channel B signal conditioner). Test routes a 10 MHz signal from the Internal reference to the internal circuitry to functionally check the operation of the instrument. COM selects a common input (a signal applied to the channel A input is routed to both the channel A and channel B signal conditioner; channel B input is floating).

2.10 OPERATION.

2.10.1 The remainder of this section deals with the use of the instrument by means of the manual controls and various practical aspects of its various features. The operation of the instrument through the use of the electrical interface is covered in Section 3.

2.10.2 General Usage Instructions.

2.10.2.1 Applying power to the instrument causes the instrument to select the TI function at "home base". A separate "home base" exists for each function and consists of an internally programmed selection of the timebase/multiplier value.

2.10.2.2 The purpose of the home base is to select an appropriate timebase/multiplier for the function selected to

make a fast, first measurement. A tabulation of the home states is given below.

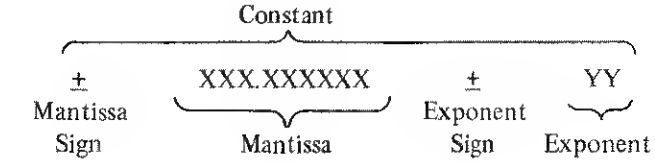
Function	Timebase/Multiplier	Scale
TI	10^{-8} sec (10 ns)	Sec
TIA	10^{1}	Sec
P	10^{-8} sec (10 ns)	Sec
PA	10^{1}	Sec
F_A	10^{-1} (.1 sec)	Hz
F_C	10^{-1} (.1 sec)	Hz
A/B	10^{1}	(Blank)
TOT	10^{1}	m

2.10.2.3 *Function Tables.* Tables 2.2 through 2.9 provide setup information and examples of measurements for each function.

2.10.3 Arithmetic Computation.

2.10.3.1 Arithmetic computation is a standard feature of the Series 9000 and permits a variety of direct conversions and manipulations of the measurement. Units such as radians, RPM, minutes, etc., can be displayed directly, either by local or remote programming, without the need of an external calculator/controller or computer.

2.10.3.2 The constant used in computation is shown below.



The mantissa may be any length from 1 to 9 digits. The exponent multiplies the mantissa by 10, raised to any power from −99 to 99. The constant appears in the display as it is entered. Once entered, the constant remains until a function key is pressed, an INT key is pressed, or until the constant is changed. Examples of operation, addition, subtraction, multiplication, division, and reciprocal are provided in tables 2.10 through 2.13.

2.10.4 Trigger Level.

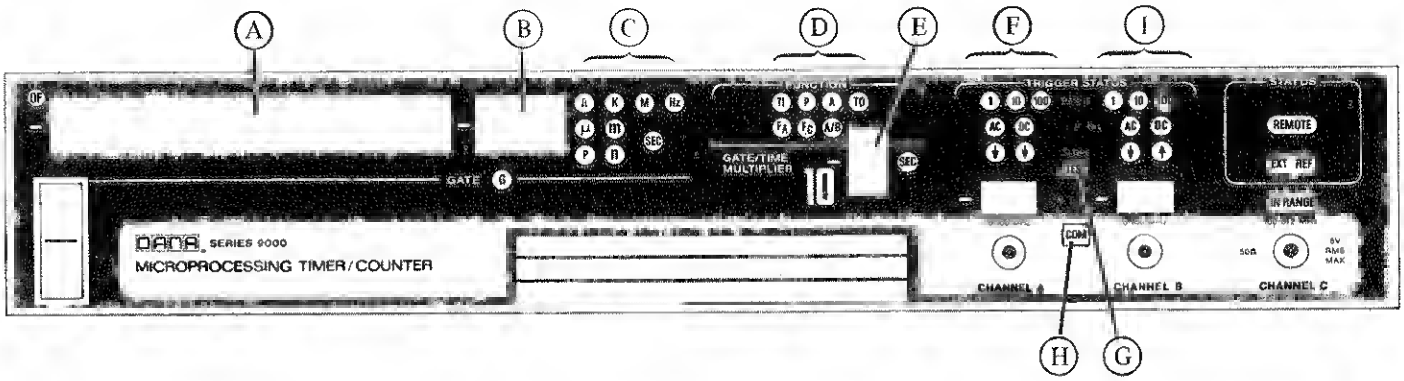
2.10.4.1 The ability to accurately select the trigger levels of channels A and B, either manually or automatically, is a particular aid in making rapid and accurate measurements. The operation of the trigger level controls is covered in table 2.14.

2.10.5 Pulse Parameter (Option 11).

2.10.5.1 The pulse parameter measurement is used in conjunction with TI and TIA modes and provides automatic measurements of pulse width, rise time and fall time.

2.10.5.2 The pulse measurements are selected on the ⎍, ⎍ and ⎺ keys, which replace the standard arithmetic keys (except reciprocal) and the exponent key. Examples of pulse measurements are shown in tables 2.15 through 2.17.

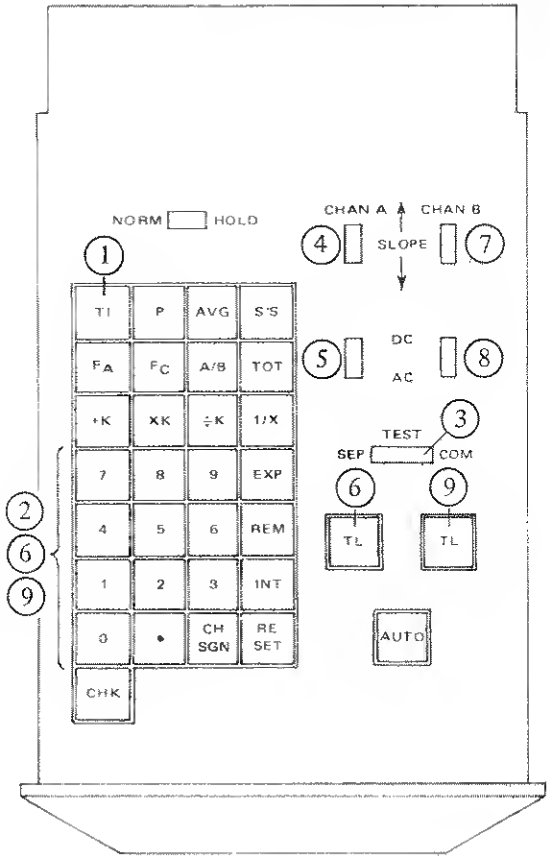
Table 2.2 - Time Interval Measurement



TIME INTERVAL

This function is used to measure the elapsed time between two separate inputs or the width of a common input pulse.

RANGE:	10 nanoseconds to 10^9 sec
INPUT SEPARATE MODE:	CH A Start and CH B Stop
COMMON MODE:	CH A Start and Stop



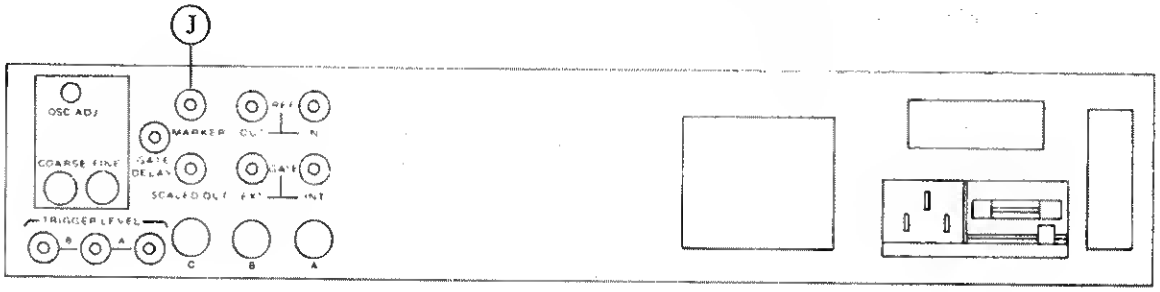
KEYBOARD

(1)	FUNCTION:	TI
(2)	RESOLUTION:	Select –8 (Home) to +1
(3)	MODE:	Select SEP or COM according to measurement
(4)	CH A SLOPE:	Select Slope of TI Start
(5)	CH A COUPLING:	Select Coupling of TI Start
(6)	CH A TRIGGER LEVEL:	TL 3-digit TL value with decimal point TL
(7)	CH B SLOPE:	Select Slope of TI Stop
(8)	CH B COUPLING:	Select Coupling of TI Stop
(9)	CH B TRIGGER LEVEL:	TL 3-digit TL value with decimal point TL

FRONT PANEL

(A)	Display:	Dependent on Input
(B)	Display:	
(C)	Display Units:	Dependent on Input
(D)	Function:	TI
(E)	Resolution:	Selected
(F)	CH A Status:	Selected
(G)	Test:	Blank
(H)	Com:	Selected
(I)	CH B Status:	Selected

Table 2.2 - Time Interval Measurement continued



REAR PANEL

(J) MARKER

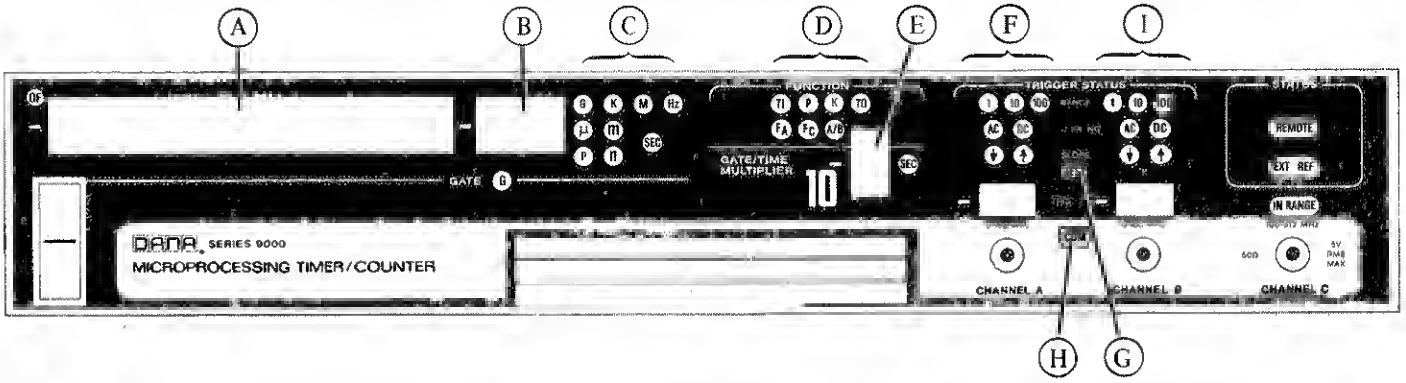
To use the marker, (J) on the rear panel, tee off of the input signal of channel A and connect to the vertical input of the oscilloscope. Connect MARKER output of counter to Z axis of oscilloscope. MARKER output voltage swing is from +3 to −12.

EXAMPLE

The Time Interval between the leading and falling edge of a 1 kHz, 5 volt square wave is to be read. The pulse is connected to the channel A input. A resolution of 10 ns is required.

(1)	TI	(A)	500.00	
(2)	−8	(B)	Blank	
(3)	COM	(C)	μ, Sec	
(4)	↑	(D)	TI	
(5)	AC	(E)	−8	
(6)	TL	(F)	↑ AC	0.00 (±.01)
	AUTO	(G)	Blank	
		(H)	Com	
(7)	↓	(I)	↑ AC	0.00 (±.01)
(8)	AC			
(9)	TL			
	AUTO			

Table 2.3 - Time Interval Average Measurement



TIME INTERVAL AVERAGE

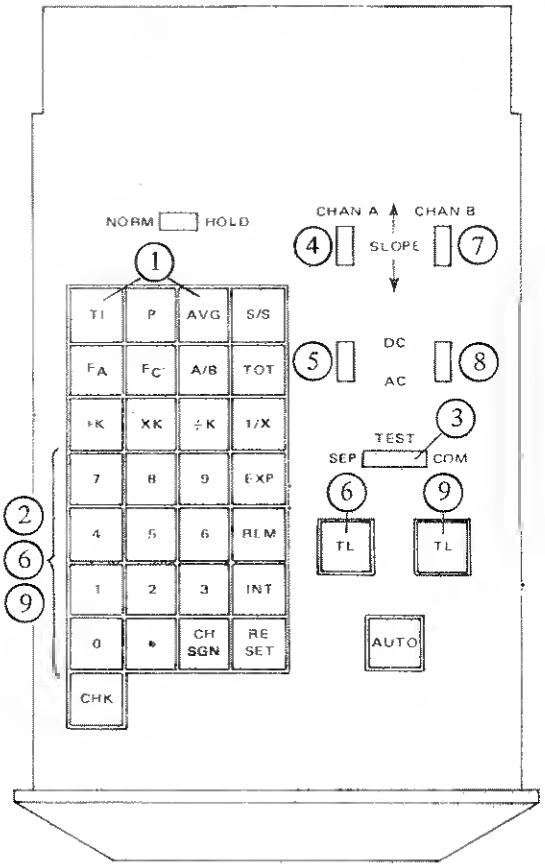
This function provides greater resolution than TI, when measuring repetitive inputs that are asynchronous with the counter's reference oscillator (100 MHz). If the input signal approaches a sub-harmonic of the reference frequency, a greater number of time intervals will have to be averaged to achieve good accuracy. The accuracy is found by the following equation.

$$\pm \text{Reference error} \pm 2 \text{ nsec} \pm \frac{(\text{Trigger error} \pm 10 \text{ nsec})}{\sqrt{\text{Number of Intervals Averaged}}}$$

Where:

$$\text{Trigger error} = \frac{\leq 0.0025\ \mu\text{sec}}{\text{Signal Slope (V/}\mu\text{sec)}}$$

RANGE:	100 pSec to 1 sec
INPUT SEPARATE MODE:	CH A Start and CH B Stop
COMMON MODE:	CH A Start and Stop



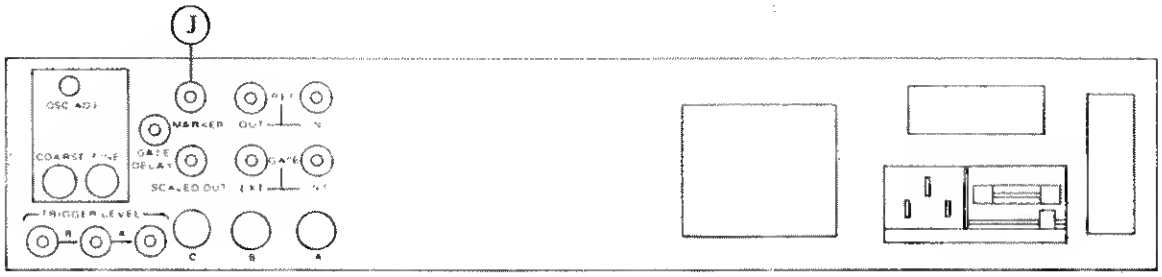
KEYBOARD

(1)	FUNCTION:	TI, AVG
(2)	MULTIPLIER:	Select
(3)	MODE:	SEP or COM according to measurement
(4)	CH A SLOPE:	Slope of Start
(5)	CH A COUPLING:	Coupling of Start
(6)	CH A TRIGGER LEVEL:	TL 3-digit value with decimal TL
(7)	CH B SLOPE:	Slope of Stop
(8)	CH B COUPLING:	Coupling of Stop
(9)	CH B TRIGGER LEVEL:	TL 3-digit value with decimal TL

FRONT PANEL

(A)	Display:	Dependent on Input
(B)	Display:	
(C)	Display Units:	Dependent on Input
(D)	Function:	TIA
(E)	Multiplier:	Selected
(F)	CH A Status:	Selected
(G)	Test:	Blank
(H)	Common:	Selected
(I)	CH B Status:	Selected

Table 2.3 - Time Interval Average Measurement continued



REAR PANEL

(J) MARKER

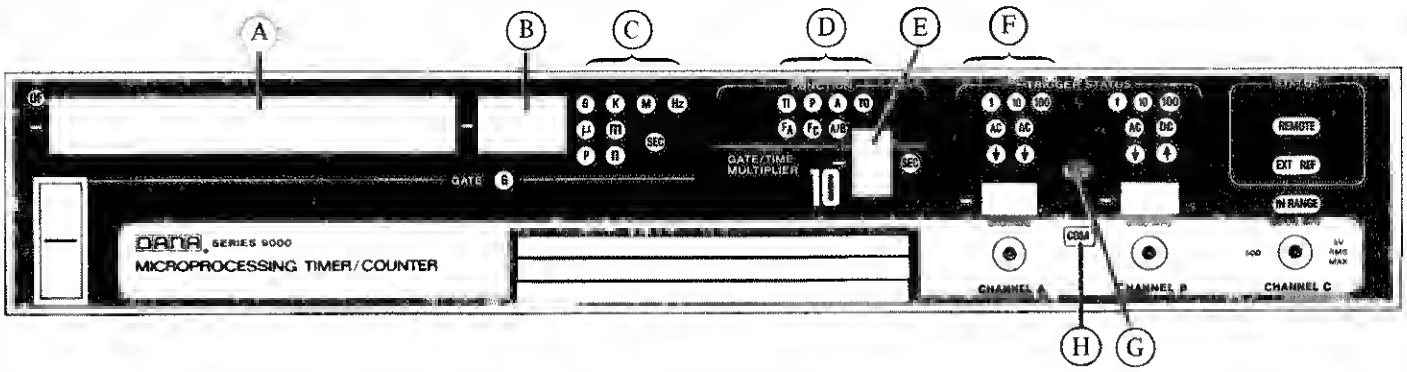
To use the marker, (J) on the rear panel, tee off of the input signal of channel A and connect to the vertical input of the oscilloscope. Connect MARKER output of counter to Z axis of oscilloscope. MARKER output voltage swing is from +3 to −12.

EXAMPLE

The Time Interval Average of a 1 volt, 1 kHz square wave signal over 10^2 periods.

(1)	TIA	(A)	500.0000
(2)	2	(B)	Blank
(3)	COM	(C)	μ, Sec
(4)	↑	(D)	TIA
(5)	AC	(E)	2
(6)	TL	(F)	↑, AC, 0.00 (±.01)
	AUTO	(G)	Blank
(7)	↓	(H)	Com
(8)	AC	(I)	↓, AC, 0.00 (±.01)
(9)	TL		
	AUTO		

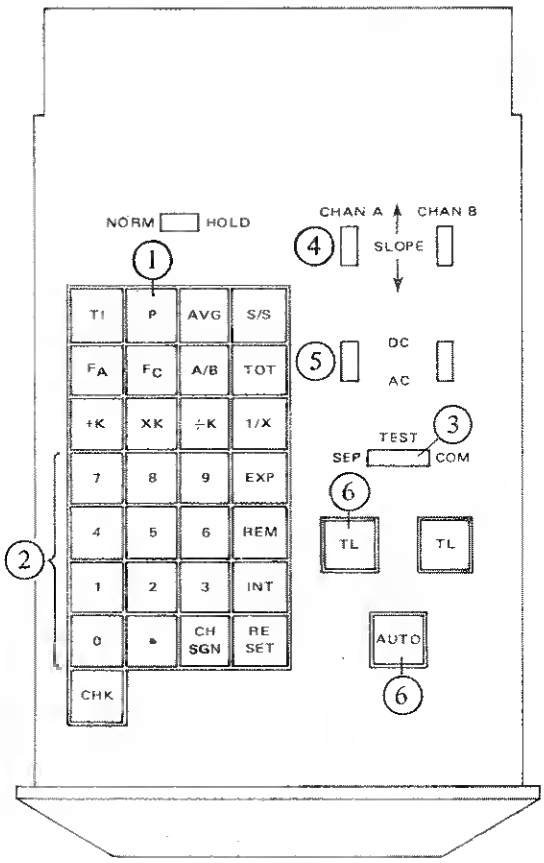
Table 2.4 - Period Measurement



PERIOD

This function measures the period of time required for one complete cycle of an input signal and is the reciprocal of the frequency of the input. For low frequency measurements (≤10 kHz) more resolution can be obtained in a reasonable time by measuring the period of the signal and deriving the reciprocal (1/X) as described in table 2.13.

RANGE:	10 nanoseconds to 10^{10} sec, 0 – 100 MHz Input
INPUT:	Channel A



KEYBOARD

(1)	FUNCTION:	P
(2)	RESOLUTION:	Select –8 to +1
(3)	MODE:	Separate
(4)	CH A SLOPE:	↑ or ↓
(5)	CH A COUPLING:	AC or DC
(6)	CH A TRIGGER LEVEL:	TL Auto

FRONT PANEL

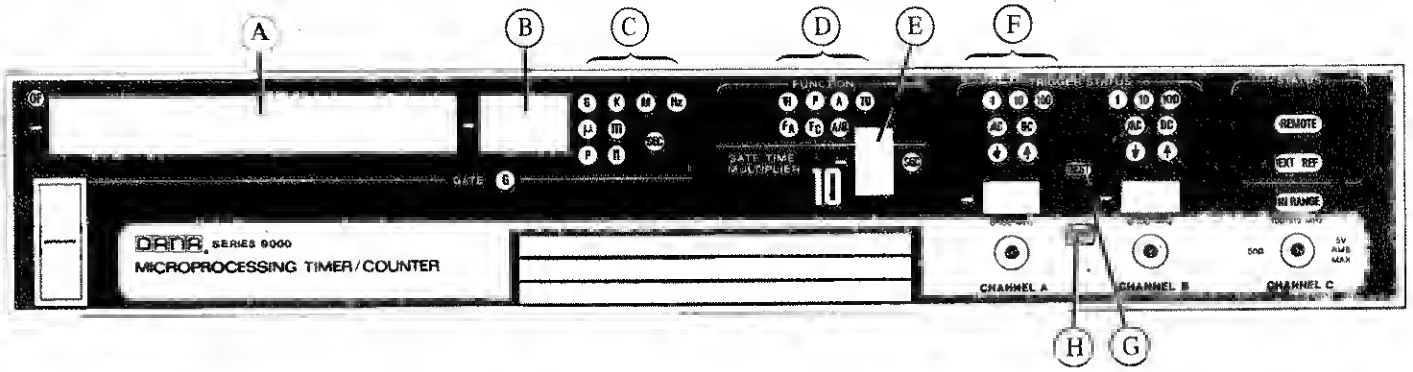
(A)	Display:	Dependent on Input
(B)	Exponent:	
(C)	Display Units:	Dependent on Input
(D)	Function:	P
(E)	Resolution:	Selected
(F)	CH A Status:	Selected & Computed
(G)	Test:	Blank
(H)	Common	Blank

EXAMPLE

The Period of a 1 volt, 1 kHz square wave signal is desired.

(1)	P	(A)	1.00000
(2)	–8	(B)	Blank
(3)	SEP	(C)	m, SEC
(4)	↑	(D)	P
(5)	AC	(E)	–8
(6)	TL	(F)	↑, AC, 0.00 ± .01
	AUTO	(G)	Blank
		(H)	Blank

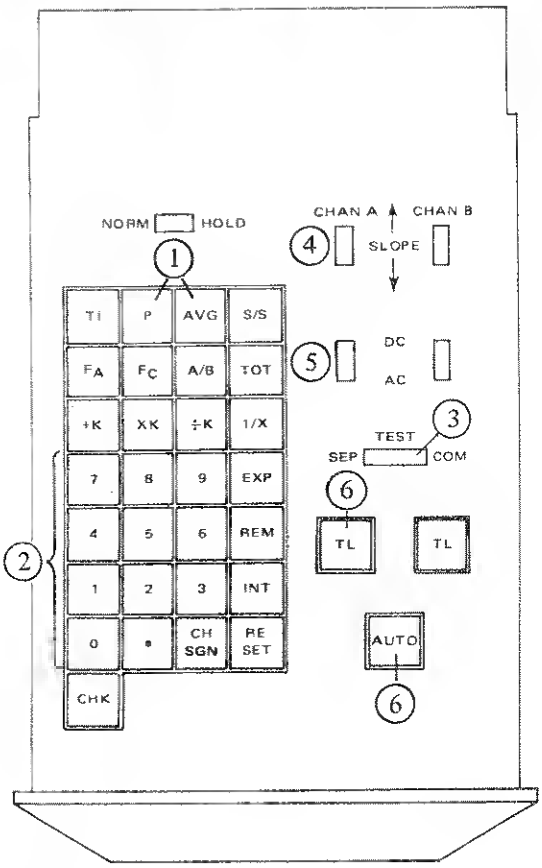
Table 2.5 - Period Average Measurement



PERIOD AVERAGE

This function permits the measurement of the period of repetitive, sinusoidal waveforms to higher resolution than can be achieved in Periodic measurement.

RANGE:	10 nanoseconds to 1 sec
INPUT:	Channel A
INTERVALS AVERAGED:	1 to 10^8



KEYBOARD

(1)	FUNCTION:	P, AVG
(2)	MULTIPLIER:	Selected, 1 – 8
(3)	MODE:	Separate
(4)	CH A SLOPE:	↑ or ↓
(5)	CH A COUPLING:	AC or DC
(6)	CH A TRIGGER LEVEL:	TL Auto

FRONT PANEL

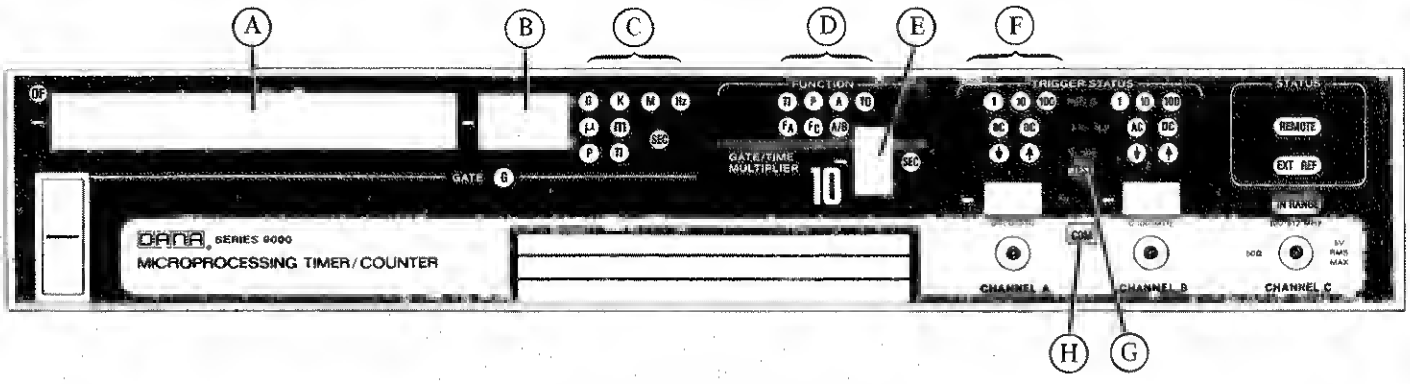
(A)	Display:	Dependent on Input
(B)	Exponent:	
(C)	Units:	Dependent on Input
(D)	Function:	PA
(E)	Multiplier:	Selected
(F)	CH A Status:	Selected, Computed
(G)	Test:	Blank
(H)	Com:	Blank

EXAMPLE

The Period Average of a 1 volt, 2 kHz square wave is desired over 10^2 periods.

(1)	P, AVG	(A)	1.500000
(2)	2	(B)	0
(3)	SEP	(C)	msec
(4)	↑	(D)	PA
(5)	AC	(E)	2
(6)	TL	(F)	1, AC, ↑ , 0.00 ± .01
	AUTO	(G)	Blank
		(H)	Blank

Table 2.6 - Frequency Measurement, 0 – 100 MHz (F_A)

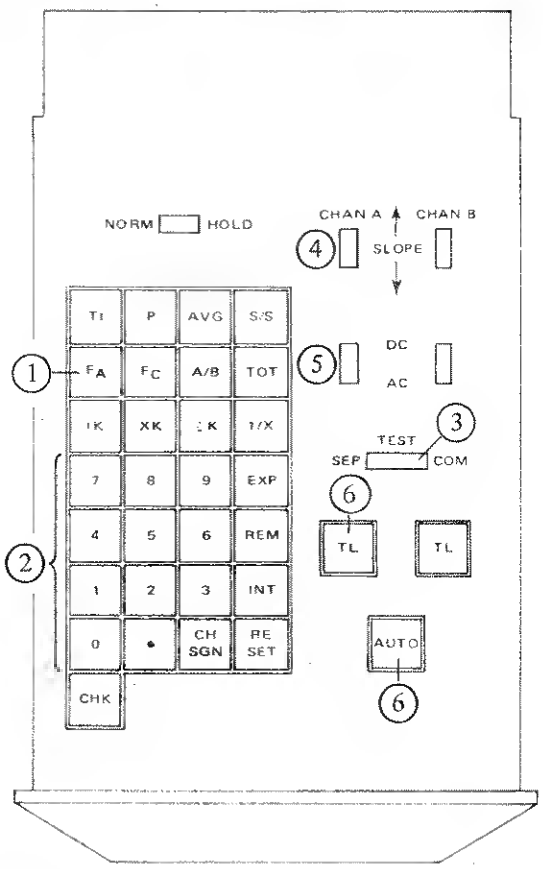


F_A

This function allows measurement of input frequencies from near DC to 100 MHz.

RANGE: 1 μS to 10 sec

INPUT: Channel A



KEYBOARD

(1)	FUNCTION:	F_A
(2)	GATE TIME:	Selected, 10^{-6} to 10^{1}
(3)	MODE:	Separate
(4)	CH A SLOPE:	↑ or ↓
(5)	CH A COUPLING:	AC or DC
(6)	CH A TRIGGER LEVEL:	TL Auto

FRONT PANEL

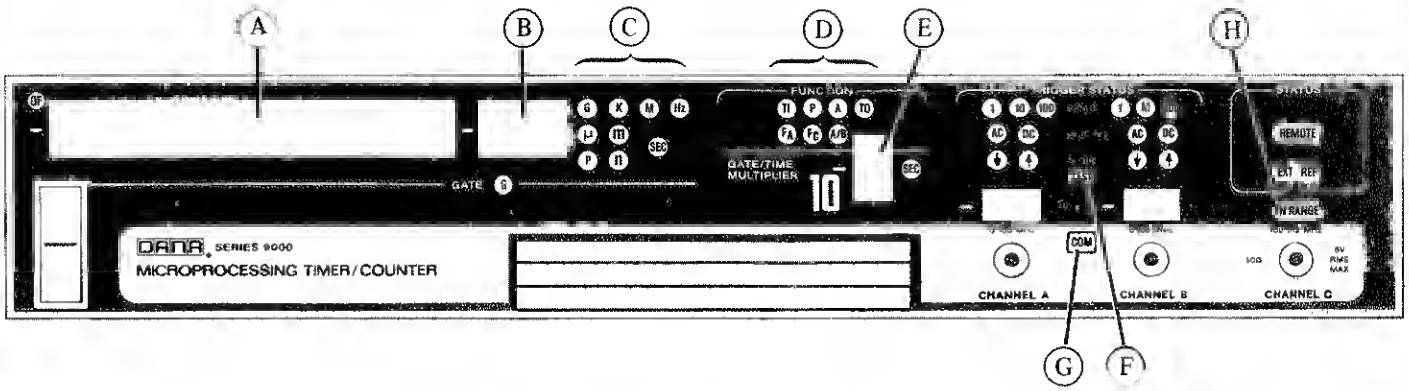
(A)	Display:	Dependent on Input
(B)	Exponent:	
(C)	Units:	Dependent on Input
(D)	Function:	F_A
(E)	Timebase:	Selected
(F)	CH A Status:	Selected, Computed
(G)	Test:	Blank
(H)	Com:	Blank

EXAMPLE

The frequency of a 1 volt, 2 kHz square wave is to be measured.

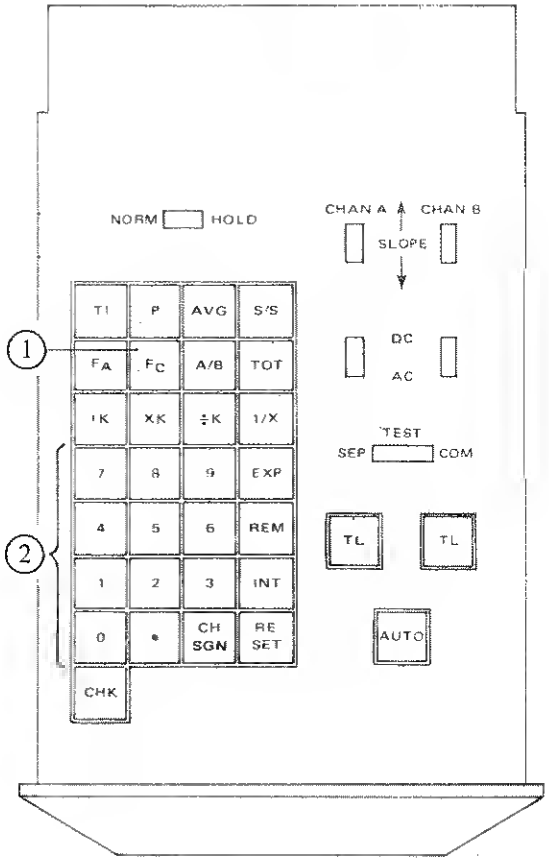
(1)	F_A	(A)	2.000
(2)	0	(B)	Blank
(3)	SEP	(C)	kHz
(4)	↑	(D)	F_A
(5)	AC	(E)	0
(6)	TL	(F)	1, AC, ↑, 0.00 (±.01)
	AUTO	(H)	Blank
		(G)	Blank

Table 2.7 - Frequency Measurement, 100 – 512 MHz (F_C), Model 9035 Only



F_C

This function allows measurement of RF signals of from 100 MHz to 512 MHz into 50Ω with signal levels down to 115 mV RMS. The application of a suitable input (proper amplitude and frequency) is indicated by an IN-RANGE light above the channel C input connector.



KEYBOARD

(1)	FUNCTION:	F_C
(2)	GATE TIME:	Selected, 10^{-6} to 10^{1}

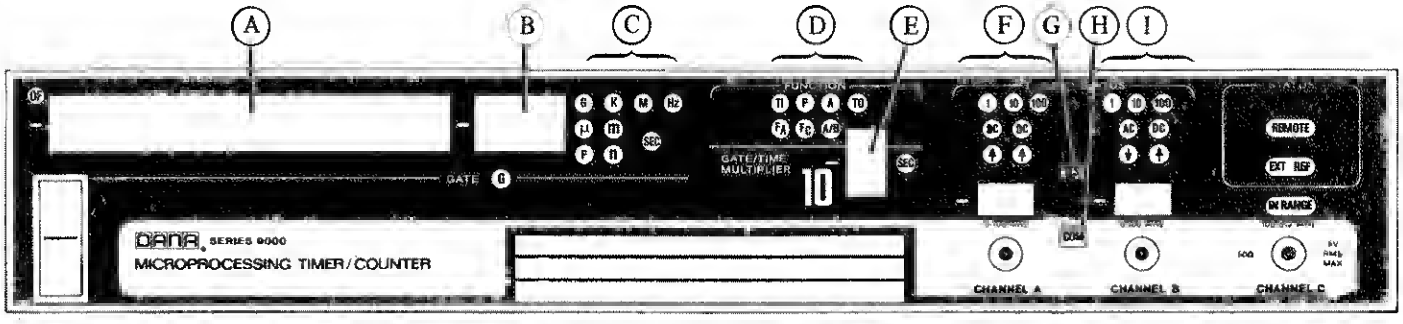
FRONT PANEL

(A)	Display:	Dependent on Input
(B)	Exponent:	
(C)	Units:	Dependent on Input
(D)	Function:	F_C
(E)	Timebase:	Selected
(F)	Test:	Blank
(G)	COM:	N/A
(H)	Acceptable Input:	IN-RANGE

EXAMPLE

An input signal of about 400 MHz is to be measured.

(1)	F_C	(A)	417.0000
(2)	−1	(B)	Blank
		(C)	MHz
		(D)	F_C
		(E)	−1
		(F)	Blank
		(G)	Blank
		(H)	IN-RANGE



A/B RATIO

This function allows the user to directly measure the ratio between two frequencies with total slope, range, coupling and trigger level control for both signal and reference input.

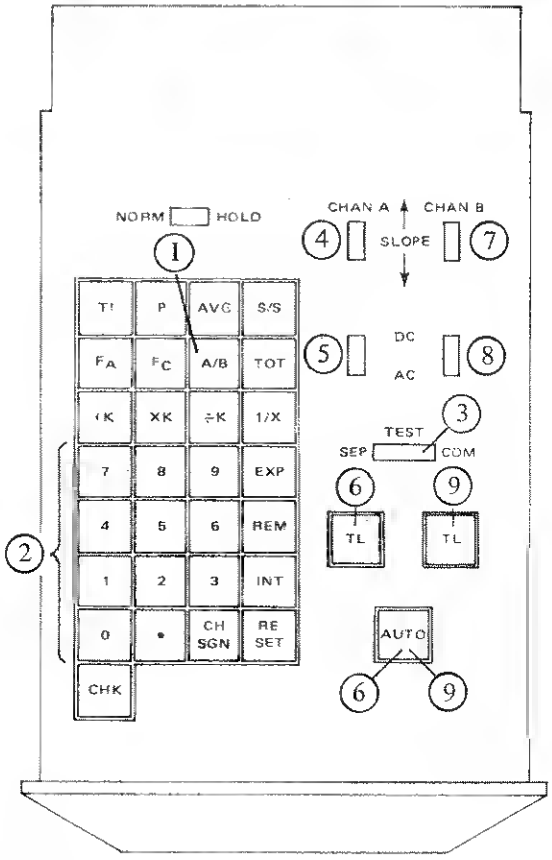
INPUT FREQUENCY RANGE:	0 – 100 MHz, both inputs
INPUT NUMERATOR:	CHANNEL A
DENOMINATOR:	CHANNEL B
MULTIPLIER:	10^0 to 10^9

KEYBOARD

(1)	FUNCTION:	A/B
(2)	MULTIPLIER:	Selected, 10^0 to 10^9
(3)	MODE:	SEP
(4)	SLOPE:	↑ or ↓
(5)	COUPLING:	AC or DC
(6)	CH A TRIGGER LEVEL:	TL Auto
(7)	SLOPE:	↑ or ↓
(8)	COUPLING:	AC or DC
(9)	CH B TRIGGER LEVEL:	TL Auto

FRONT PANEL

(A)	Display:	Dependent on Input
(B)	Exponent:	
(C)	Display Units:	Dependent on Input
(D)	Function:	A/B
(E)	Multiplier:	Selected
(F)	CH A Status:	Selected, Computed
(G)	Test:	Blank
(H)	Mode:	Selected
(I)	CH B Status:	Selected, Computed

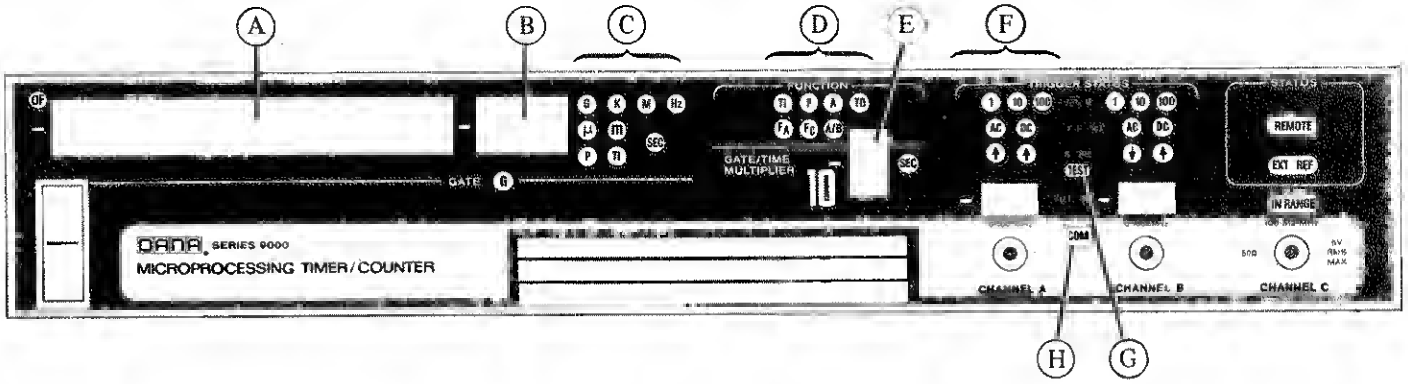


EXAMPLE

The ratio of two frequencies is desired; a 1 volt, 1 kHz square wave is to be compared with a 1 volt RMS, 1.1 kHz sinewave.

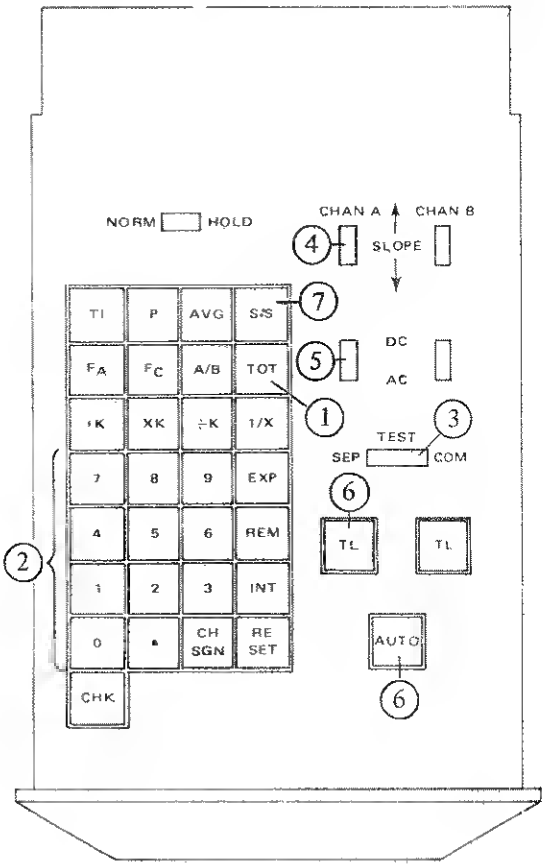
(1)	A/B	(A)	909.
(2)	3	(B)	Blank
(3)	SEP	(C)	m
(4)	↑	(D)	A/B
(5)	AC	(E)	3
(6)	TL AUTO	(F)	1, AC, ↑, 0.00 (±.01)
(7)	↑	(G)	Blank
(8)	AC	(H)	Blank
(9)	TL AUTO	(I)	1, AC, ↑, 0.00 (±.01)

Table 2.9 - Totalize



TOTALIZE

In this function, the instrument registers the aggregate of a series of input pulses, over a time period initiated by the user. The time period is controlled manually by the START/STOP key on the keyboard or electrically through the EXT GATE BNC (I) on the rear panel. The input signal can also be scaled in this function from 10^0 to 10^9. The output is available at the SCALED OUT BNC (J) on the rear panel.



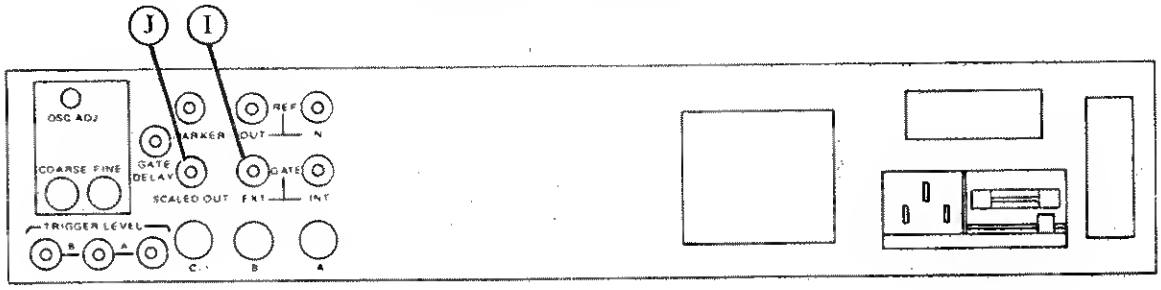
KEYBOARD

(1)	FUNCTION:	TOT
(2)	SCALING FACTOR:	10^0 to 10^9
(3)	MODE:	SEP
(4)	CH A SLOPE:	↓ or ↑
(5)	CH A COUPLING:	AC or DC
(6)	CH A TRIGGER LEVEL:	TL Auto
(7)	START/STOP:	Press to Start, press to Stop

FRONT PANEL

(A)	Display:	Dependent on Input
(B)	Exponent:	
(C)	Units:	Dependent on Input
(D)	Function:	TOT
(E)	Factor:	Selected, 10^0 to 10^9
(F)	CH A Status:	Selected, Computed
(G)	Test:	Blank
(H)	Com:	Blank

Table 2.9 - Totalize continued



REAR PANEL

(I) EXTERNAL GATE

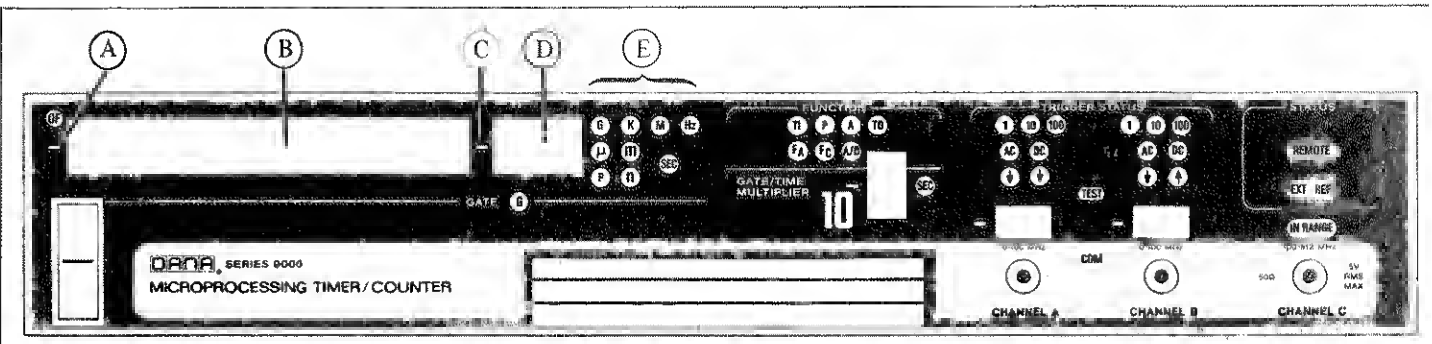
(J) SCALED OUT

EXAMPLE

The operation of a 1 Volt pulse, 12-bit word generator is to be checked.

(1)	TOT	(A)	12
(2)	1	(B)	Blank
(3)	SEP	(C)	m
(4)	↑	(D)	TOT
(5)	DC	(E)	1
(6)	TL	(F)	1, DC, ↑ .500
	.500	(G)	Blank
	TL	(H)	Blank
(7)	S/S		
	Trigger Generator		
	S/S		

Table 2.10 - Arithmetic Computation, Addition

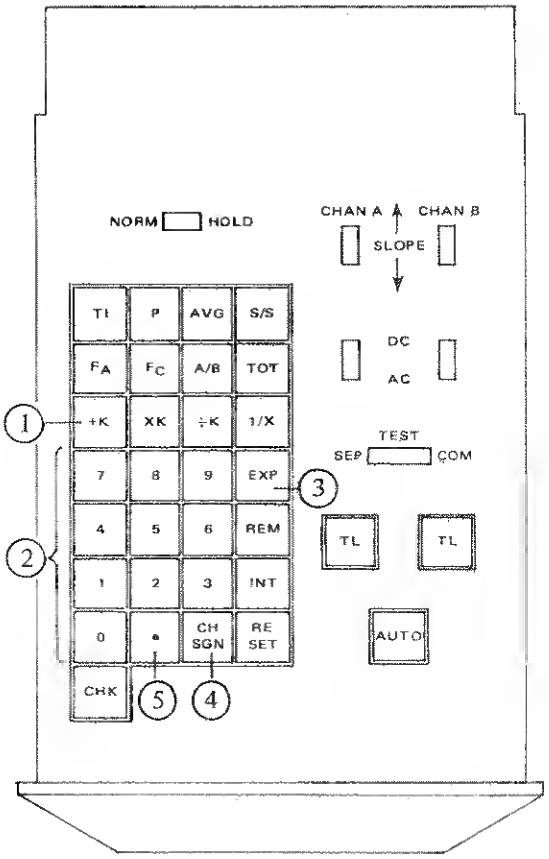


ADDITION

This operation, selected with the +K key on the keyboard, allows the user to add or subtract a constant from any measurement. The mantissa of the constant can be either + or – and have from 1 to 9 digits. The exponent can be from ±0 to ±99.

The constant must be within the resolution of the measurement; any portion of the constant outside the measurement resolution is ignored.

The results of the addition or subtraction must be within the maximum allowable for the display (±999.999999 ± 99).



KEYBOARD

(1)	ARITHMETIC FUNCTION:	+K
(2)	CONSTANT:	Any number 1 to 9 digits long
(3)	EXPONENT:	Exponent can be any number 1 to 99
(4)	CHANGE SIGN:	Changes sign of constant or exponent
(5)	DECIMAL:	Decimal point for constant

FRONT PANEL

(A)	Polarity of Display:	Dependent on input
(B)	Display:	Dependent on input
(C)	Polarity of Exponent:	Dependent on input
(D)	Exponent:	Dependent on input
(E)	Display Units:	Hz and SEC blanked

OPERATION		ACTION
1.	Depress +K key	μP is signalled and display is blanked
2.	Enter constant	Constant is entered on the display
3.	Depress +K key	Arithmetic operation is performed

Table 2.10 - Arithmetic Computation, Addition continued

EXAMPLE

37.45 milliseconds is to be added to the period measurement of a 1 Hz signal.

Measure the period of a 1 second pulse at a resolution of 10^{-4} (see table 2.4).

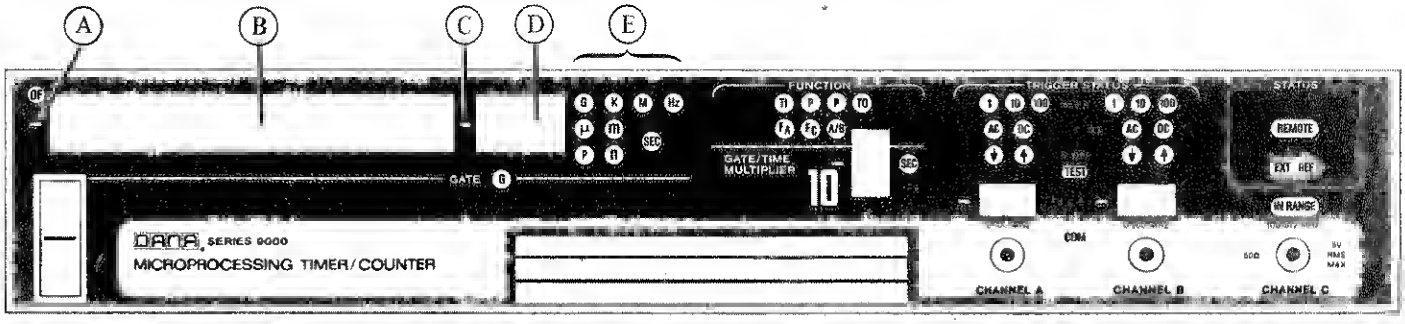
(1)	+K	(A)	Blank (Positive)
(2)	37.4	(B)	1.0374
(3)	EXP	(C)	Blank
(4)	–	(D)	Blank
(2)	3	(E)	Blank
(1)	+K		

EXAMPLE

The deviation of a 10 MHz frequency to 10 Hz resolution is to be monitored. 10,000,000 will be subtracted from the measurement. Measure the frequency (F_A) of a 10 MHz signal at a gate time of 10^{-1} (see table 2.6).

(1)	+K	(A)	Dependent on Deviation
(4)	–	(B)	Blank or difference (amount of deviation)
(2)	10	(C)	Blank
(3)	EXP	(D)	Blank
(2)	6	(E)	Blank
(1)	+K		

Table 2.11 - Arithmetic Computation, Multiplication



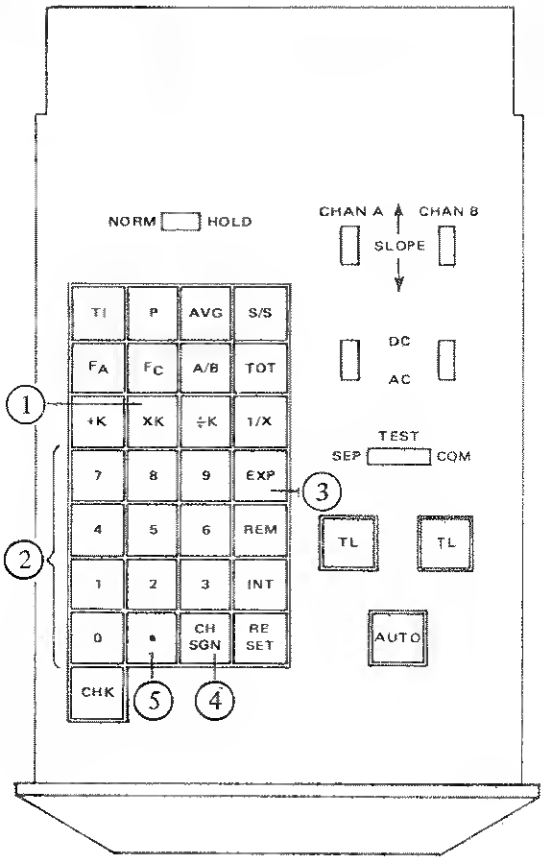
MULTIPLICATION

This operation, selected with the xK key on the keyboard, allows the user to multiply the measurement by a constant. The mantissa of the constant can be either + or – and have from 1 to 9 digits. The exponent can be from ±0 to ±99.

The product must be within the maximum allowable for the display (±999.999999 ± 99).

KEYBOARD

(1)	ARITHMETIC FUNCTION:	xK
(2)	CONSTANT:	Any number, 1 to 9 digits long
(3)	EXPONENT:	Number can be raised to any power 1 to 99
(4)	CHANGE SIGN:	Changes sign of constant or exponent
(5)	DECIMAL:	Decimal point for constant



FRONT PANEL

(A)	Polarity of Display:	Dependent on input
(B)	Display:	Dependent on input
(C)	Polarity of Exponent:	Dependent on input
(D)	Exponent:	Dependent on input
(E)	Display Units:	Hz and SEC Blanked

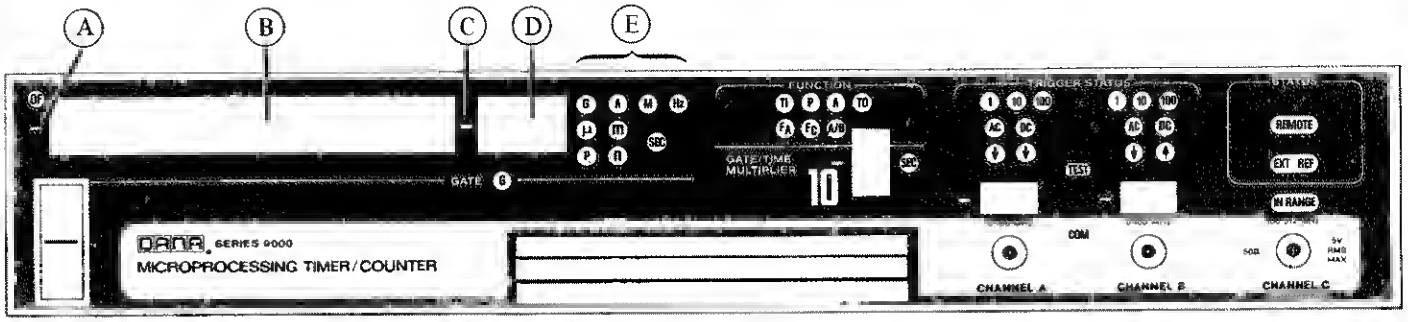
OPERATION		ACTION
1.	Depress xK key	μP is signalled and display is blanked
2.	Enter constant	Constant is entered on the display
3.	Depress xK key	Multiplication is performed

EXAMPLE

10 MHz is to be converted to radians to 7 place accuracy. Measure the frequency (F_A) of a 10 MHz signal at a gate time of 10^{-1} (see table 2.6).

(1)	xK	(A)	Blank
(2)	6.283185	(B)	62.83185
(3)	EXP	(C)	Blank
(1)	xK	(D)	Blank
		(E)	M

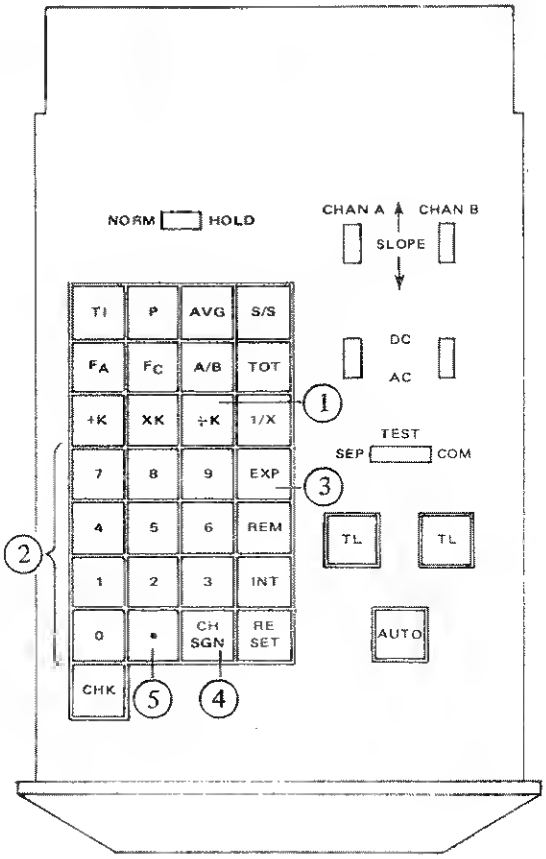
Table 2.12 - Arithmetic Computation, Division



DIVISION

This operation, selected with the ÷K key on the keyboard, allows the user to divide the measurement by a constant. The mantissa of the component can be either + or − and have from 1 to 9 digits. The exponent can be from ±0 to ±99.

The quotient must be within the maximum allowable for the display (±999.999999 ± 99).



KEYBOARD

(1)	ARITHMETIC FUNCTION:	÷K
(2)	CONSTANT:	Any number, 1 to 9 digits long
(3)	EXPONENT:	Number can be raised to any power 1 to 99
(4)	CHANGE SIGN:	Changes sign of constant or exponent
(5)	DECIMAL:	Decimal point for constant

FRONT PANEL

(A)	Polarity of Display:	Dependent on input
(B)	Display:	Dependent on input
(C)	Polarity of Exponent:	Dependent on input
(D)	Exponent:	Dependent on input
(E)	Display Units:	Hz and SEC Blanked

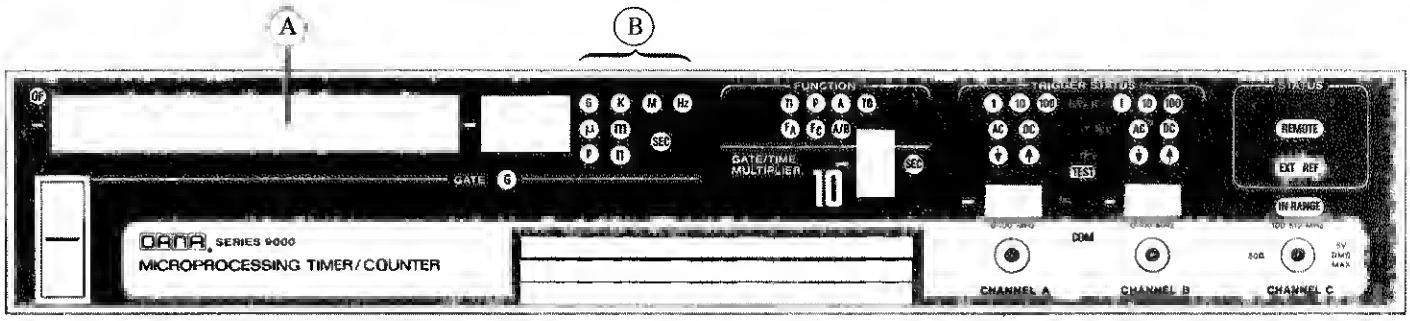
EXAMPLE

10 MHz is to be divided by 50. Measure the frequency (F_A) of a 10 MHz at a resolution of 10 Hz (see table 2.6).

OPERATION		ACTION
1.	Depress ÷K key	μP is signalled and display is blanked
2.	Enter constant	Constant is interred on the display
3.	Depress ÷K key	Division is performed

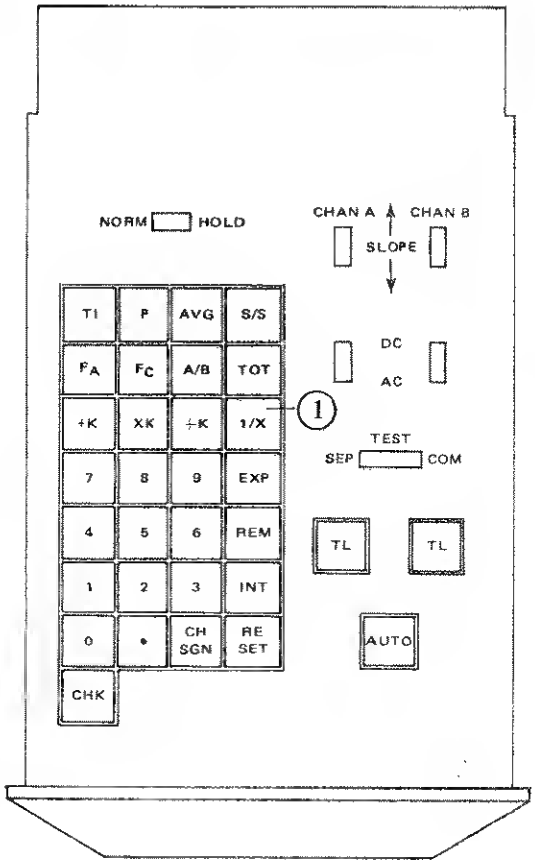
(1)	÷K	(A)	Blank
(2)	50	(B)	200.0000
(1)	÷K	(C)	Blank
		(D)	Blank
		(E)	K

Table 2.13 - Arithmetic Computation, Reciprocal



RECIPROCAL

This operation, selected with the 1/X key on the keyboard, allows the user to take the reciprocal of the measured value. This permits the accurate measurement of low frequencies by taking the reciprocal of a period or period average measurement. High resolution period measurements can also be made by taking the reciprocal of a frequency measurement.



KEYBOARD

(1) ARITHMETIC FUNCTION: 1/X

FRONT PANEL

(A) Display: Dependent on input

(B) Display Units: Dependent on input

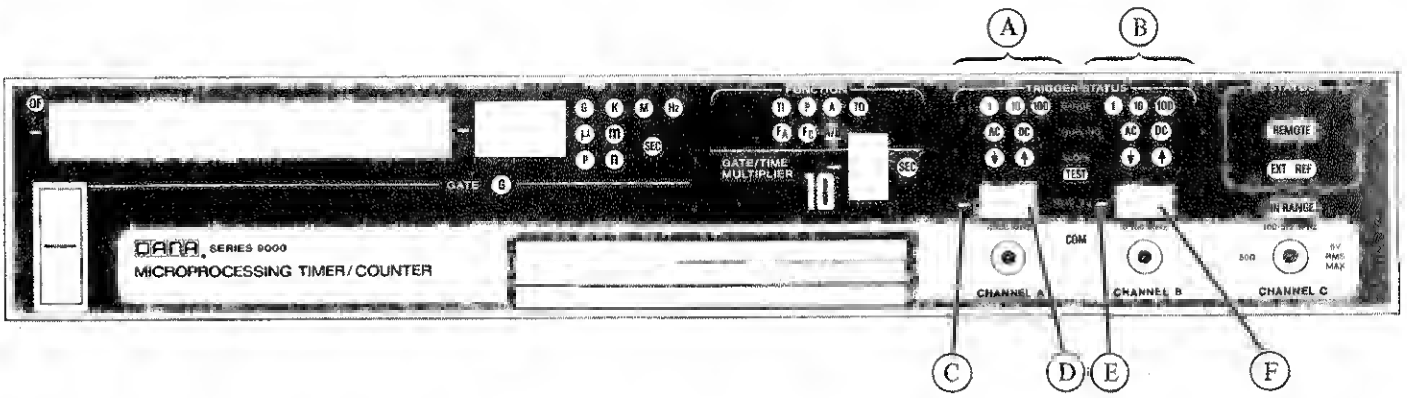
EXAMPLE

The frequency of a 5 kHz signal is desired. Measure the period (P) of a 5 kHz signal at a resolution of 10 nA (see table 2.6).

1. 1/X

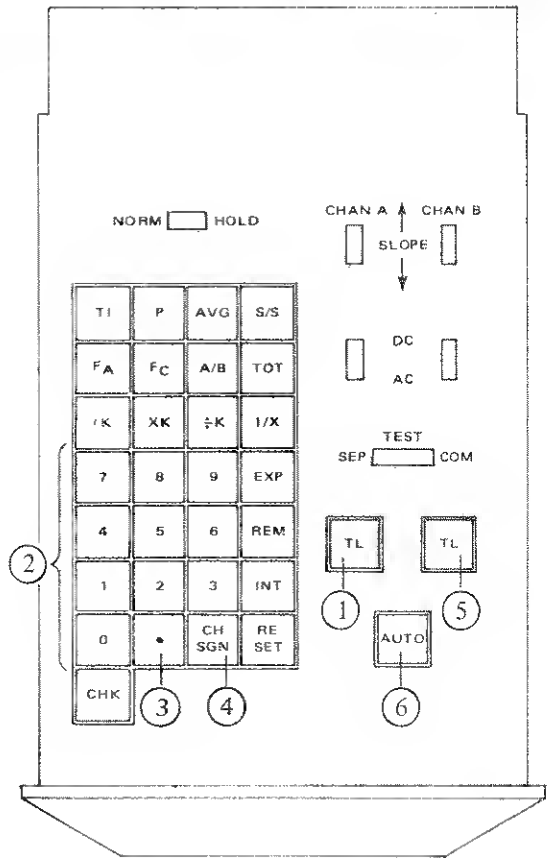
(A) 5.000

(B) kHz



TRIGGER LEVEL

Both the channel A and channel B signal conditioning circuits contain a nine digit DAC, capable of providing stable trigger levels from −3.00V to +3.00V in 12.5 millivolt steps. Range attenuators in each circuit also permits trigger level settings from +30.0V to −30.0V and from +300V to −300V. The level of each channel is set individually, either manually or automatically. The numeric value of the trigger settings is displayed in volts on the instrument front panel. The range of the trigger level is determined by the placement of the decimal in manual range and automatically computed in auto range. In manual selection, inputs greater than the allowable for each range span is rejected.



KEYBOARD

(1)	TRIGGER LEVEL:	Selects Trigger Level A
(2)	TRIGGER LEVEL VALUE:	3-digit Trigger Level value for manual selection
(3)	DECIMAL:	Selects TL range in manual selection
(4)	CHANGE SIGN:	Selects TL polarity
(5)	TRIGGER LEVEL:	Selects Trigger Level B
(6)	AUTO:	Automatically selects Trigger Level and Range

FRONT PANEL

(A)	Range:	Indicates channel A range
(B)	Range:	Indicates channel B range
(C)	Polarity:	Indicates channel A TL polarity
(D)	Trigger Level:	3-digit display of channel A TL
(E)	Polarity:	Indicates channel B TL polarity
(F)	Trigger Level:	3-digit display of channel B TL

Table 2.14 - Trigger Level continued

MANUAL OPERATION		ACTION
1.	Depress TL of desired channel	μP is locked in on Trigger Level
2.	Enter TL value	DAC is programmed and value displayed
3.	Depress TL of desired channel	Value is set and μP is released from TL

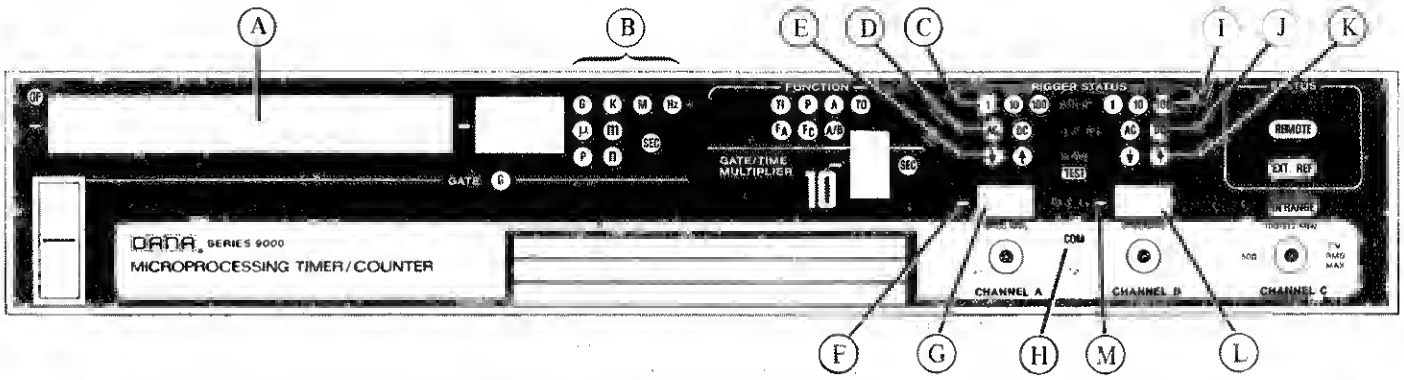
AUTO OPERATION		ACTION
1.	Depress TL of desired channel	μP is locked in on Trigger Level
2.	Depress AUTO	μP measures the p-p value of the input signal, computes the 50% point of the waveform and programs the DAC to the 50% level. Level is set and μP is released from TL

EXAMPLE

The channel A and channel B trigger levels are to he set to accommodate a 1V square wave for TIA measurement.

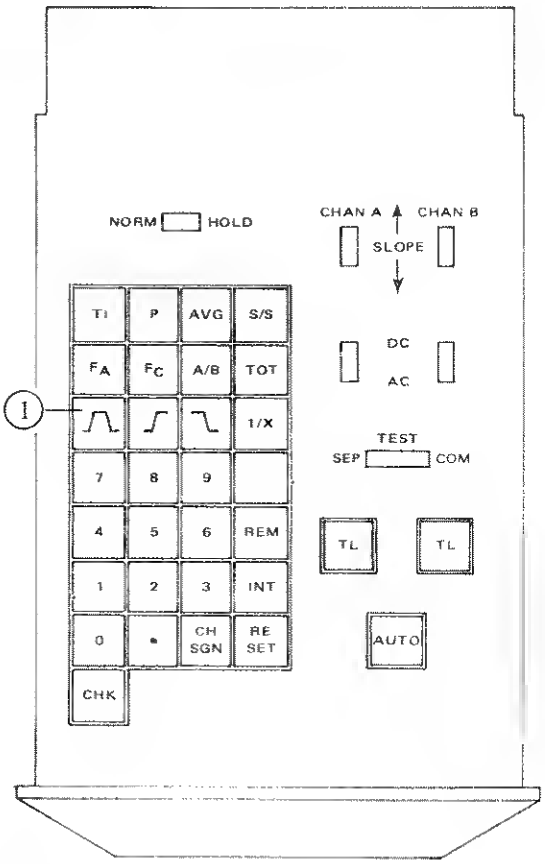
(1)	TL of channel A	(A)	1
(2)	0	(B)	.1
(3)	.	(C)	Blank
(2)	11	(D)	0.11
(1)	TL of channel A	(E)	–
(5)	TL of channel B	(F)	0.51
(4)	CH SGN		
(2)	0		
(3)	.		
(2)	51		
(5)	TL of channel B		

Table 2.15 - Pulse Width (Option 11)



PULSE WIDTH

This operation, selected with the ⎍ key on the keyboard, allows the user to automatically take pulse width measurements in the Time Interval and Time Interval Average modes. The selection of the pulse width key automatically selects DC coupling on both channels, common, + slope on channel A, – slope on channel B. It measures the peak-to-peak value of the input signal, sets the proper trigger levels for both channels at the 50% point of the waveform and displays the time interval of the positive portion of the input signal on the display.



KEYBOARD

(1) PULSE WIDTH: ⎍

FRONT PANEL

(A)	Display:	Value of input pulse width
(B)	Display Scale:	Dependent on input
(C)	Channel A Range:	Dependent on input
(D)	Channel A Coupling:	DC
(E)	Channel A Slope:	↑
(F)	Channel A TL Polarity:	Dependent on input
(G)	Channel A TL Value:	Dependent on input
(H)	COM:	COM
(I)	Channel B Range:	Dependent on input
(J)	Channel B Coupling:	DC
(K)	Channel B Slope:	↓
(L)	Channel B TL Polarity:	Dependent on input
(M)	Channel B TL Value:	Dependent on input

OPERATION	ACTION
1. Select ⎍ key (TI or TIA only)	All trigger status controls are automatically set to measure the positive portion of an input pulse at the 50% level

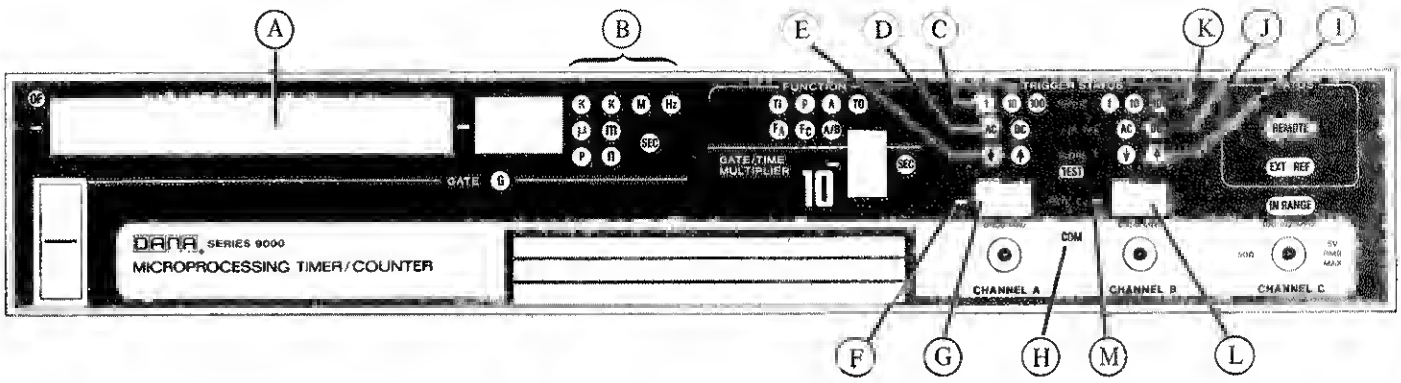
EXAMPLE

The pulse width of a 1 kHz 1V square wave is to be measured. Select TIA at 10^2.

(1) ⎍

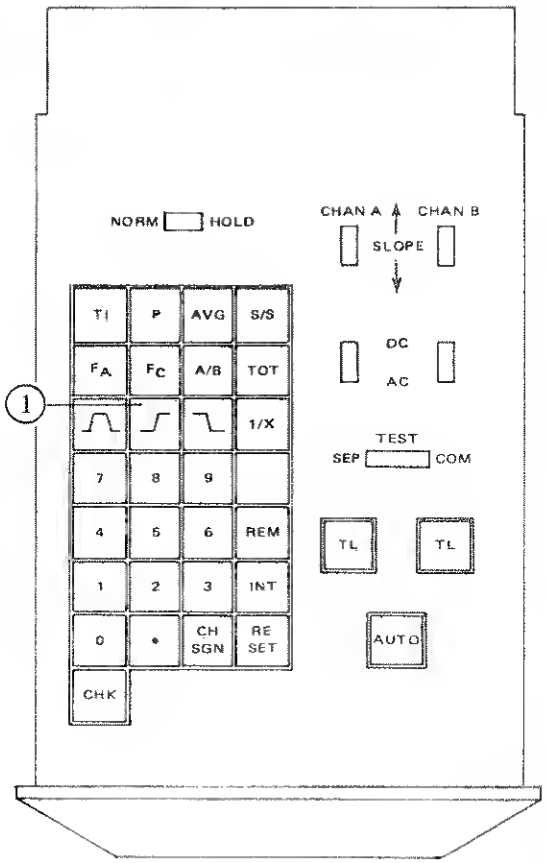
(A)	501.2955	(H)	COM
(B)	μsec	(I)	1
(C)	1	(J)	DC
(D)	DC	(K)	↓
(E)	↑	(L)	0.49
(F)	Blank	(M)	Blank
(G)	0.49		

Table 2.16 - Rise Time (Option 11)



RISE TIME

This operation, selected with the ⎍ key on the keyboard, provides automatic rise time measurements in the Time Interval and Time Interval Average modes. The selection of the rise time key selects DC coupling and + slope on both channels and common. It measures the peak-to-peak value of the input signal and, from this value, sets the channel A trigger to 7 to 10% level and channel B trigger to the 90% level. The interval between channels A and B is measured and appears in the display.



KEYBOARD

(1) RISE TIME: ⎍

FRONT PANEL

(A)	Display:	Dependent on input
(B)	Display Scale:	Dependent on input
(C)	Channel A Range:	Dependent on input
(D)	Channel A Coupling:	DC
(E)	Channel A Slope:	↑
(F)	Channel A TL Polarity:	Dependent on input
(G)	Channel A TL Value:	Dependent on input
(H)	COM:	COM
(I)	Channel B Range:	Dependent on input
(J)	Channel B Coupling:	DC
(K)	Channel B Slope:	↑
(L)	Channel B TL Value:	Dependent on input
(M)	Channel B TL Polarity:	Dependent on input

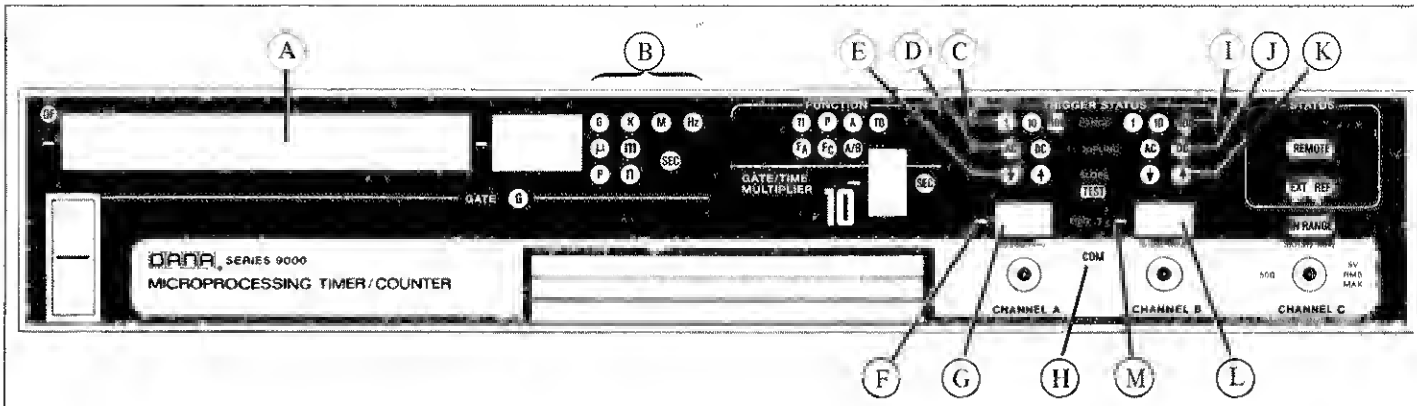
EXAMPLE

The rise time of a 1V, 1 kHz square wave is to be measured. Select TIA to 10^3.

(1) ⎍

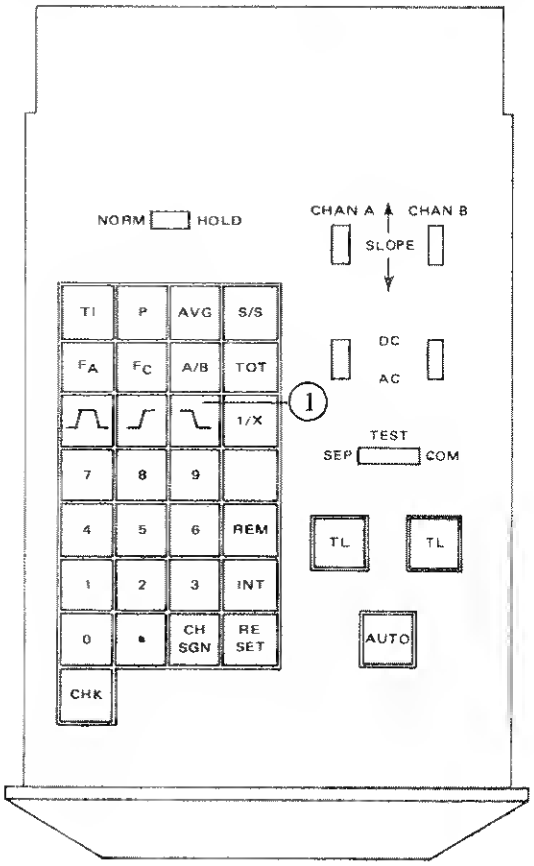
(A)	507.10	(H)	COM
(B)	nsec	(I)	1
(C)	1	(J)	DC
(D)	DC	(K)	↑
(E)	↑	(L)	0.86
(F)	Blank	(M)	Blank
(G)	0.10		

Table 2.17 - Fall Time (Option 11)



FALL TIME

This operation, selected with the ⌞ key on the keyboard, provides automatic fall time measurements in the Time Interval and Time Interval Average modes. The selection of the fall time key selects DC coupling and + slope on both channels and common. It measures the peak-to-peak value of the input signal and, from this value, sets the channel A trigger to 7 to 90% level and channel B trigger to the 10% level. The interval between channels A and B is measured and appears in the display.



KEYBOARD

(1) FALL TIME: ⌞

FRONT PANEL

(A)	Display:	Dependent on input
(B)	Display Scale:	Dependent on input
(C)	Channel A Range:	Dependent on input
(D)	Channel A Coupling:	DC
(E)	Channel A Slope:	↓
(F)	Channel A TL Polarity:	Dependent on input
(G)	Channel A TL Value:	Dependent on input
(H)	COM:	COM
(I)	Channel B Range:	Dependent on input
(J)	Channel B Coupling:	DC
(K)	Channel B Slope:	↓
(L)	Channel B TL Value	Dependent on input
(M)	Channel B TL Polarity:	Dependent on input

EXAMPLE

The fall time of a 1V, 1 kHz square wave is to be measured. Select TIA to 10^3.

(1) ⌞

(A)	1.61710	(H)	COM
(B)	nsec	(I)	1
(C)	1	(J)	DC
(D)	DC	(K)	↓
(E)	↓	(L)	0.10
(F)	Blank	(M)	Blank
(G)	0.89		

SECTION 3 SYSTEMS INTERFACE

3.1 GENERAL.

3.2 This section covers the operation and provides hook-up information for the option 55 and option 57 ASCII interface.

3.3 OPTION 55 GENERAL PURPOSE INTERFACE BUS.

3.3.1 The option 55 provides remote programming of all keyboard inputs and digital output data defining all front panel indicators. Inputs and outputs for the option are on a bi-directional bus via a 24 pin connector on the rear panel. The pin location, line identification, and operation of the option are in compliance with IEEE standard 488-1975, "IEEE STANDARD DIGITAL INTERFACE FOR PROGRAMMABLE INSTRUMENTATION". The option provides interface capability with other instruments and a controller also utilizing the "interface bus" structure*.

3.3.2 By assigning an available address to the 9000, it can be "called up" by the controller or another device on the bus without interfering with any other unit on the bus. Switches located on the option board permit the programming of the instrument address. The coding used for the address on the option board is ASCII (hexidecimal). Any one of 31 codes can be used for the address of an instrument but a total of 14 is the maximum number of addresses that can be used on one bus.

3.4 BUS DESCRIPTION.

3.4.1 Of the twenty-four lines available at the connector (shown in table 3.1) seven are grounds, one is a shield, and the remaining 16 lines are the data bus lines. All of the data bus lines are either input or output lines and have the following characteristics:

Logic Levels: 1 = Lo = $\leq$.8V
0 = Hi = $\geq$ 2.0V

Input Loading: Each input = one TTL load

Output: The output is capable of driving 14 interface bus loads. It consists of an open collector driver and is capable of sinking 48 mA with a maximum voltage drop of 0.4 volts. See IEEE Electrical Specifications.

*Reference IEEE Standard 488-1975 (SH, AH, RL0, L1, T3)

Table 3.1 - Connector Contact Assignments

Contact	Signal Line	Contact	Signal Line
1	DIO 1	13	DIO 5
2	DIO 2	14	DIO 6
3	DIO 3	15	DIO 7
4	DIO 4	16	DIO 8
5		17	REN
6	DAV	18	Gnd, (6)
7	NRFD	19	Gnd, (7)
8	NDAC	20	Gnd, (8)
9	IFC	21	Gnd, (9)
10		22	Gnd, (10)
11	ATN	23	Gnd, (11)
12	SHIELD	24	Gnd, LOGIC

NOTE: Gnd (n) refers to the signal ground return of the referenced contact.

3.4.2 The data bus lines as shown in figure 3.1 consist of three functionally separate sets: Data, Transfer, and Interface.

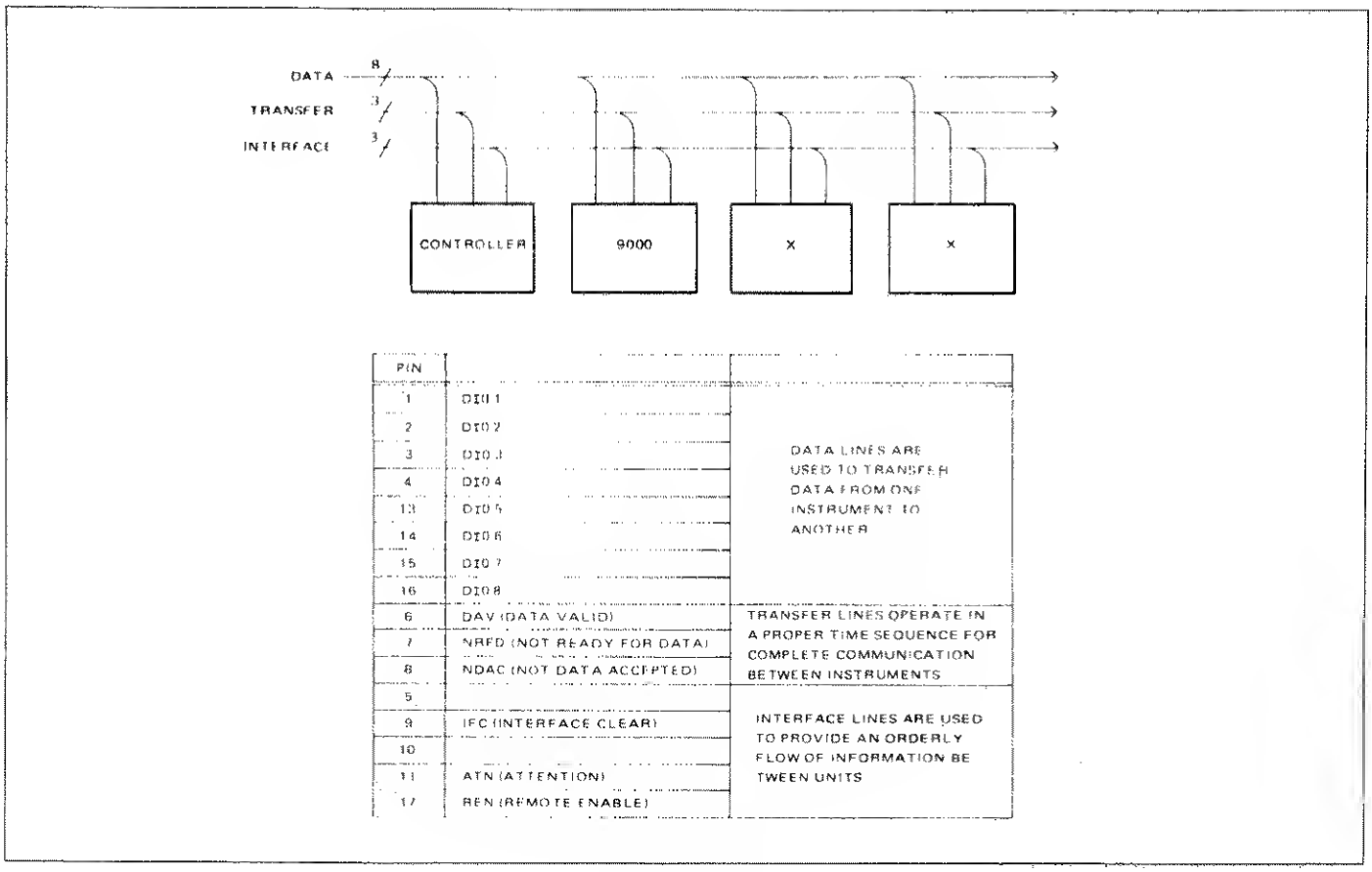
3.4.2.1 *Data.* The data lines consist of lines D10-1 through D10-8. These lines are the lines over which data flows between all instruments on the bus in bit parallel, byte serial form.

3.4.2.2 *Transfer.* The transfer lines consist of: DAV (data valid), NDAC (not data accepted), and NRFD (not ready for data). These lines provide communication between the instrument that is talking and the instrument that is listening to synchronize the flow of information across the eight data lines.

a. DAV. Signifies that valid information is available on the data lines.

b. NDAC. Signifies instrument ready to accept information.

c. NRFD. Signifies information is accepted by the listener.



PIN		
1	DIO 1	DATA LINES ARE USED TO TRANSFER DATA FROM ONE INSTRUMENT TO ANOTHER
2	DIO 2	
3	DIO 3	
4	DIO 4	
13	DIO 5	
14	DIO 6	
15	DIO 7	
16	DIO 8	
6	DAV (DATA VALID)	TRANSFER LINES OPERATE IN A PROPER TIME SEQUENCE FOR COMPLETE COMMUNICATION BETWEEN INSTRUMENTS
7	NRFD (NOT READY FOR DATA)	
8	NDAC (NOT DATA ACCEPTED)	
5		INTERFACE LINES ARE USED TO PROVIDE AN ORDERLY FLOW OF INFORMATION BE TWEEN UNITS
9	IFC (INTERFACE CLEAR)	
10		
11	ATN (ATTENTION)	
17	REN (REMOTE ENABLE)	

Figure 3.1 - Data Bus Lines

3.4.2.3 The three interface lines coordinate the flow of information on the bus.

a. IFC. Places system in a known state.

b. ATN. Indicates nature of information on data lines. (Lo is Address, Hi is Data.)

c. REN. Commands instruments to select Remote operation. (Lo for Remote.)

3.4.3 Handshake.

3.4.3.1 The handshake is the process by which each data byte is transferred from the talker to the listener.

3.4.3.2 Shown in table 3.2 is the timing relationship between the DAV, NRFD, and NDAC lines, used to transfer data bytes.

3.5 ADDRESS SWITCH.

3.5.1 The address of the 9000 is programmed by setting the position of four switches on a 5 switch dual in-line package switch. The fifth switch selects Print only. The available switch combinations, the talk address characters, and the listen address characters are given in table 3.3. The only limitation on the address selected is to select a code that no other unit on the bus is using. The Print switch is used for handshake operation with a printer and is not selected when the instrument is wired into a bus.

3.5.2 The address is in ASCII code and has three characters representing the same address according to whether the instrument is to talk with the display data, to talk with no display data, or to listen with the display lit. For example, if the address 0000 is selected, the three ASCII characters used for this address are:

@	Which programs TALK, Display Operative
A	Which programs TALK, no Display Data
Space	Which programs LISTEN, Display Data

Note that A_0 determines when the display is lit. LISTEN always has a lit display. Note also that A_5 and A_6 determine when a LISTEN or TALK mode is selected. To UNLISTEN an instrument use "?". To UNTALK an instrument use "UNTALK" command, (ASCII decimal 95) (–).

Table 3.2 - Handshake Sequence

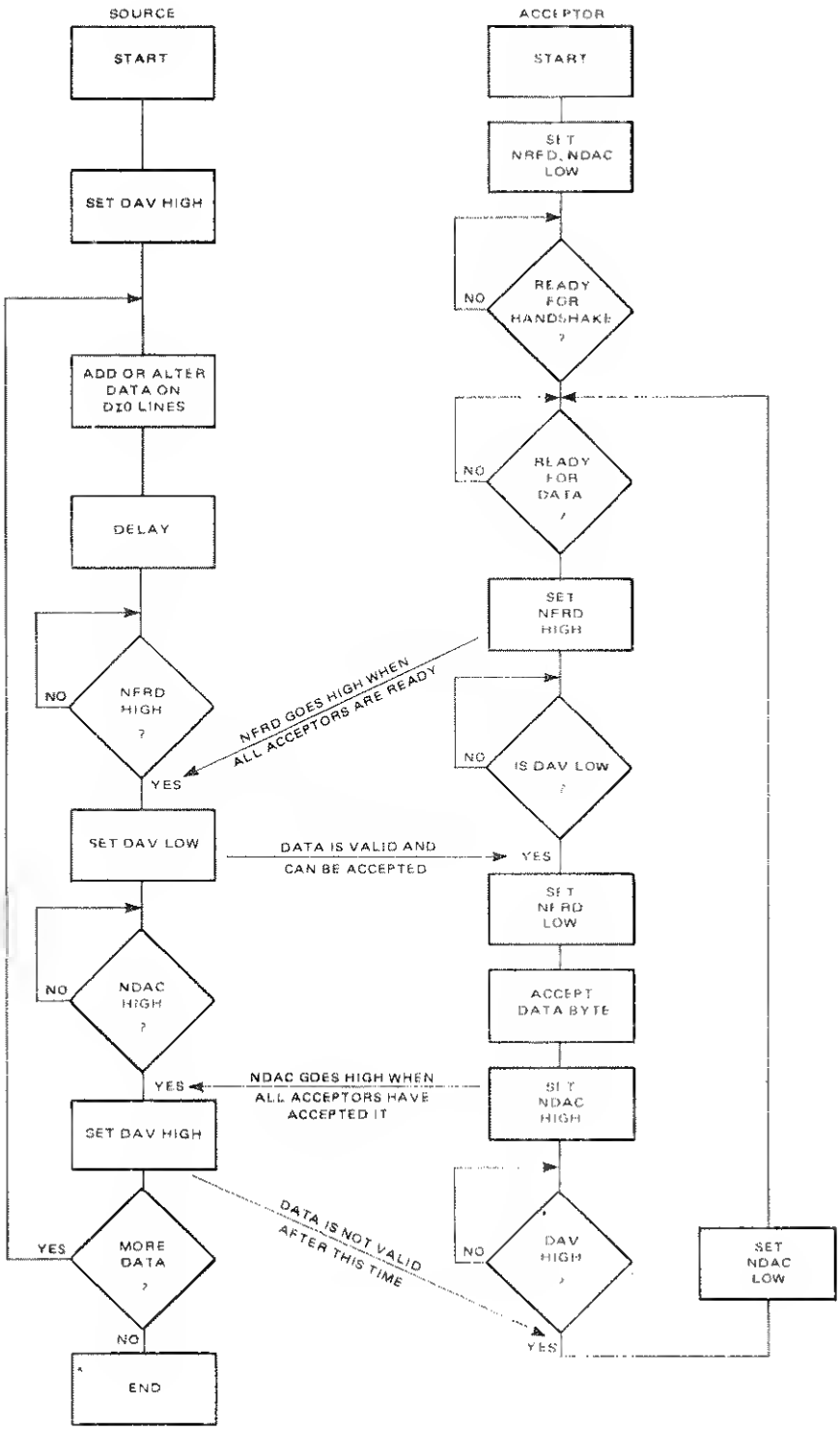


Table 3.3 - Address Codes

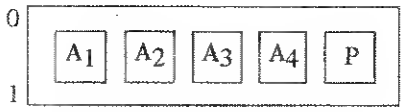
A_6	A_5	A_4 *	A_3 *	A_2 *	A_1 *	A_0	CHARACTERS	
							TALK	LISTEN
		0	0	0	0	0	@	SP
		0	0	0	0	1	A	
		0	0	0	1	0	B	"
		0	0	0	1	1	C	
		0	0	1	0	0	D	$
		0	0	1	0	1	E	
		0	0	1	1	0	F	&
		0	0	1	1	1	G	
		0	1	0	0	0	H	(
		0	1	0	0	1	I	
		0	1	0	1	0	J	☆
		0	1	0	1	1	K	
		0	1	1	0	0	L	,
		0	1	1	0	1	M	
		0	1	1	1	0	N	.
		0	1	1	1	1	O	
		1	0	0	0	0	P	ϕ
		1	0	0	0	1	Q	
		1	0	0	1	0	R	2
		1	0	0	1	1	S	
		1	0	1	0	0	T	4
		1	0	1	0	1	U	
		1	0	1	1	0	V	6
		1	0	1	1	1	W	
		1	1	0	0	0	X	8
		1	1	0	0	1	Y	
		1	1	0	1	0	Z	:
		1	1	0	1	1	[	
		1	1	1	0	0	\	<
		1	1	1	0	1	]	
		1	1	1	1	0	^	>

A_6	A_5	
0	1	LISTEN
1	0	TALK

A_0 **	TALK
0	DISPLAY LIT
1	NO DISPLAY

*A_1 through A_4 are selected on the Bus board

**A_0 is fixed at 0 for Listen Address only



(ADDRESS Switch on Parallel ASCII Board)

3.6 FIELD INSTALLATION.

3.6.1 The 9000 can be ordered with the option 55 included or it can be installed in the field. The field kit includes:

Option 55 GPIB Assembly	406789	–
ROM 4001-16	230225	U30
ROM 4001-17	230226	U31
ROM 4001-18	230263	U33
ROM 4001-19	230264	U34
ROM 4001-20	230265	U35
ROM 4001-21	230266	U36
Mounting Bracket	730960	–
Mounting Screws (2)	610801	–
Mounting Washers (2)	617102	–

3.6.2 Procedure.

a. Remove power to the 9000. Loosen the four screws that mount the bottom cover to the instrument and remove cover. Remove connector J211 plate on rear panel.

b. Mount the GPIB assembly in location J6, with connector J211 towards the rear of the instrument. Mount the mounting bracket to the rear panel and the connector J211 to the mounting bracket.

c. Remove the Computer III board (J7) from the 9000 and install the ROMs as shown in figure 3.2. Reinsert the Computer III board at J7.

d. Replace the bottom cover.

3.7 CONNECTION WITH A BUS.

3.7.1 The option 55 is in accordance with IEEE Specification 488-1975 and can be wired into or replace a piece of equipment wired into an existing bus. Connector contact assignments are given in table 3.1.

3.7.2 Printer Operation.

3.7.2.1 The simplest hookup using the option 55 is between the 9000 and an ASCII printer or ASCII converter driving a printer. In this configuration the eight data lines (DI0-1 through DI0-8) and the three handshake lines (DAV, NRFD, and NDAC) are used (ATN line Hi). The procedure for printer operation is as follows:

a. Set the PRINT switch on the 5-switch dual in-line package, located on the GPIB board (this requires opening the 9000 case as described in paragraph 5.3).

b. Connect an appropriate cable between the units and apply power to both units.

c. The desired operational setup data is programmed into the 9000 via the keyboard.

d. To initiate the recording device, the remote key is selected on the 9000 keyboard.

3.8 OPERATING THE BUS.

3.8.1 Establishing two way communication between the 9000 and the controller requires the correct use and proper sequencing of the bus "language". This language consists of operating keys (command, stop, end, etc.) which perform controller operations, bus control codes, addressing codes, and control codes for operating the 9000. To illustrate this, the following paragraphs describe the programming of the 9000 with an HP9821A calculator/controller with the Model 20 Peripheral Control II.

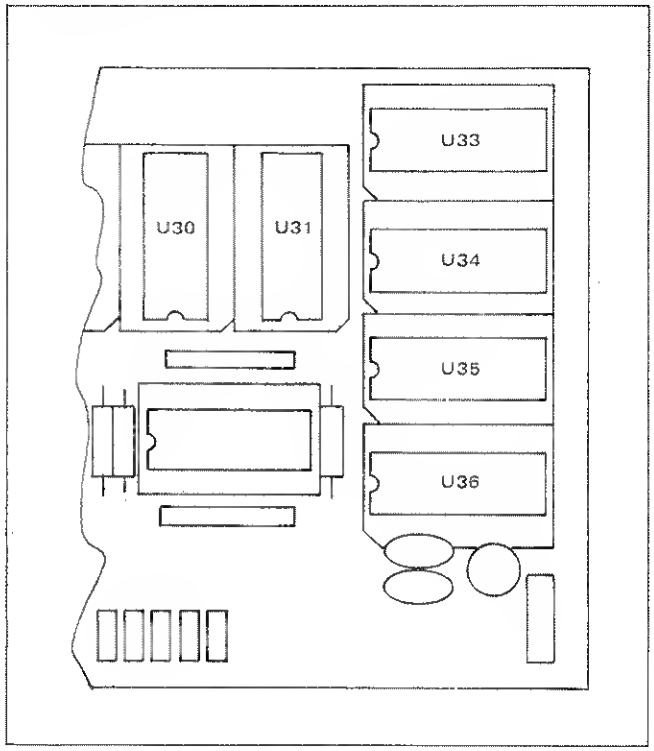


Figure 3.2 - ROM Location

3.8.2 Remote.

3.8.2.1 The code for selecting remote operation is: FMT Y3 , Z; WRT 13. This entry into the controller pulls the REN line low and assures the instruments on the bus are in the remote mode.

3.8.3 Commands.

3.8.3.1 The basic form of the command is:

CMD "(command string)", "(program code string)"

ATN Line Lo ATN Line Hi

with the program code string optional. The command string is used to address a talker and listener and the program code string is used to transmit control instructions to a device. The comma and quotes are part of the command form and must be included for proper operation.

3.8.4 Addressing.

3.8.4.1 The basic form of the address is:

"(UNLISTEN) (UNTALK) (TALK ADDRESS) (LISTEN ADDRESS)"

The unlisten code is "?" and the untalk code is " ←"; these commands are used to clear the bus of any talkers and listeners. The controller talk code is "U" and listen code is "5". The 9000 talk and listen codes can be selected from table 3.3. For all examples used in this section, the 9000 listen code is "SPACE" and the talk code is "@" for talk with 9000 display lit or "A" for talk with 9000 display blank.

3.8.5 9000 Commands.

3.8.5.1 The following steps illustrate the standard program commands.

1. Don't change function: "," (go to step 8)
2. Select function: P, PA, TI, TA, FA, FC, RA, TO
3. Select polarity of timebase: –, +
4. Select timebase value: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9

5_1. Arithmetic operation: refer to table 3.8

5_2. Invert: I(return to 5_1)

5_3. Bypass steps 5_1, 5_2: ","

6. Select test: Y
   N
7. Select Common: Y
   N
8. Select channel: A / B } (go to step 10)
9. No channel: , (go to step 15)
10. Select DC: Y (DC)
    N (AC)
11. Select slope: +
    –
12. Select auto trigger: Y (return to step 8)
    N (go to step 13)
13. Trigger polarity: +
    –
14. Numeric value: X.XX, XX.X or XXX (go to 8)
15. ,

Table 3.4 - Data Output Format

Ordered Output	Note	Address 0	Address 1
1. Trigger Level A Sign			
2. Trigger Level A Data	3 digits + 0 or 1 decimal point		
3. Carriage Return			
4. Line Feed			
5. Trigger Level B Sign			
6. Trigger Level B Data	3 digits +0 or 1 decimal point		
7. Carriage Return			
8. Line Feed			
9. Mantissa Sign			
10. Decimal Point			
11. Mantissa	0 to 9 digits		
12. Exponent Designator			
13. Exponent Sign			
14. Exponent	2 digits		
15. Overflow	0 or 1 digit		
16. Carriage Return			
17. Line Feed			

Table 3.5 - Option 55 Program Format with HP9821A Calculator

STEP	
0	FORMAT Y 3 , Z : WRITE 13 STORE
1	BUS COMMAND " ? → U SPACE " , " FA – 2 , N N A N + Y , " STORE
2	BUS COMMAND " 5 GO TO " STORE
3	FORMAT FIXED N 04.2 ; READ 13 , X ; PRINT " TRIGGER SPACE A " STORE
4	PRINT X STORE
5	FORMAT FIXED N 04.2 ; READ 13 ; X ; PRINT " TRIGGER SPACE B " STORE
6	PRINT X STORE
7	FORMAT FLOAT N 16.9 ; READ 13 , X ; PRINT " PA " STORE
8	PRINT X STORE
9	END STORE

3.8.6 **Controller Format.**

3.8.6.1 The controller stores and prints the data generated by the 9000, through a handshake sequence. To extract the information, specific format instructions relating to the length of data strings and the presence or absence of the display must be programmed. As a convenience, titles for the data may also be included in the program.

3.8.6.2 The data from the 9000 is in a fixed format. The controller format therefore, must be written to conform to the order of the 9000 data. This is shown in table 3.4.

3.8.6.3 The trigger levels are printed once. That is because these are fixed levels and do not change unless programmed to do so. The data can be printed as often as desired. To reprint the trigger levels, the 9000 must be readdressed. Refer to controller manual for specific operating instructions.

3.8.7 **Operating Sequences.**

3.8.7.1 Certain operations may be required during the generation of a program or when changes are to be made. The following provide the sequences for the most common of these.

1. To obtain a printout of a program, press:
   END LIST
2. To recall a number, press:
   GO TO (number) RECALL
3. To go to a new number, press:
   GO TO (number) EXECUTE
4. To run a program, press:
   STOP CLEAR END

   RUN PROGRAM
5. To complete a program, press:
   STOP

3.8.8 **Programming Example.**

3.8.8.1 The sequence in table 3.5 provides an example of the programming steps taken to set the 9000 in frequency A mode, with a timebase of –2, in auto trigger. The procedure also sets up the printout format. Step numbers are not programmed in.

A tape run of the program will look like the sample shown below*.

```
0:
FMT Y3,Z;WRT 13⊢
1:
CMD "→?U ","FA-2,
NNAN+Y,"⊢
2:
CMD "→5@"⊢
3:
FMT FXD 04.2;
RED 13,X;PRT "TR
 GGER A"⊢
4:
PRT X⊢
5:
FMT FXD 04.2;
RED 13,X;PRT "TR
IGGER B"⊢
6:
PRT X⊢
7:
FMT FLT 16.9;
RED 13,X;PRT "PA
 ⊢
8:
PRT X⊢
9:
END ⊢
Z12267
P147
```

A program run produces the tape shown below.

```
TRIGGER A
                0.00
TRIGGER B
                 .10
PA
 1.101000000E 06
```

*More programming examples are provided in Appendix A at end of Section.

3.9 SOFTWARE DESCRIPTION.

3.9.1 The software defines the sequence of steps that must be followed to correctly program and extract data from the instrument. The software is such that the instrument will accept only those commands compatible with a particular command step, and reject all others. An incorrect command causes the program to "loop" at that point, until the proper command is received. The display will program up to this point.

3.9.2 The software is the internal programming of the option and is thus applicable to all interfacing hookups, regardless of the type of controller used. In table 3.4 is illustrated the basic flow format of the option. On tables 3.5 through 3.9 is provided the programming in detail. Table 3.10 illustrates the software of the option when a printer is used..

3.10 OPTION 11 PULSE PARAMETER.

3.10.1 To accommodate changes in operation of instruments equipped with the option 11, changes in the interface software are also made. These differences are indicated in the "option 11" tables, 3.11 through 3.13.

3.10.2 Text changes include replacing reference to "Arithmetic operation" to "Pulse Parameter" and changing the field kit as shown below.

Standard	Option 11
230225	230292
230226	230293
230263	230294
230264	230295
230265	230296

Table 3.6 - Option 55 Software Block Diagram

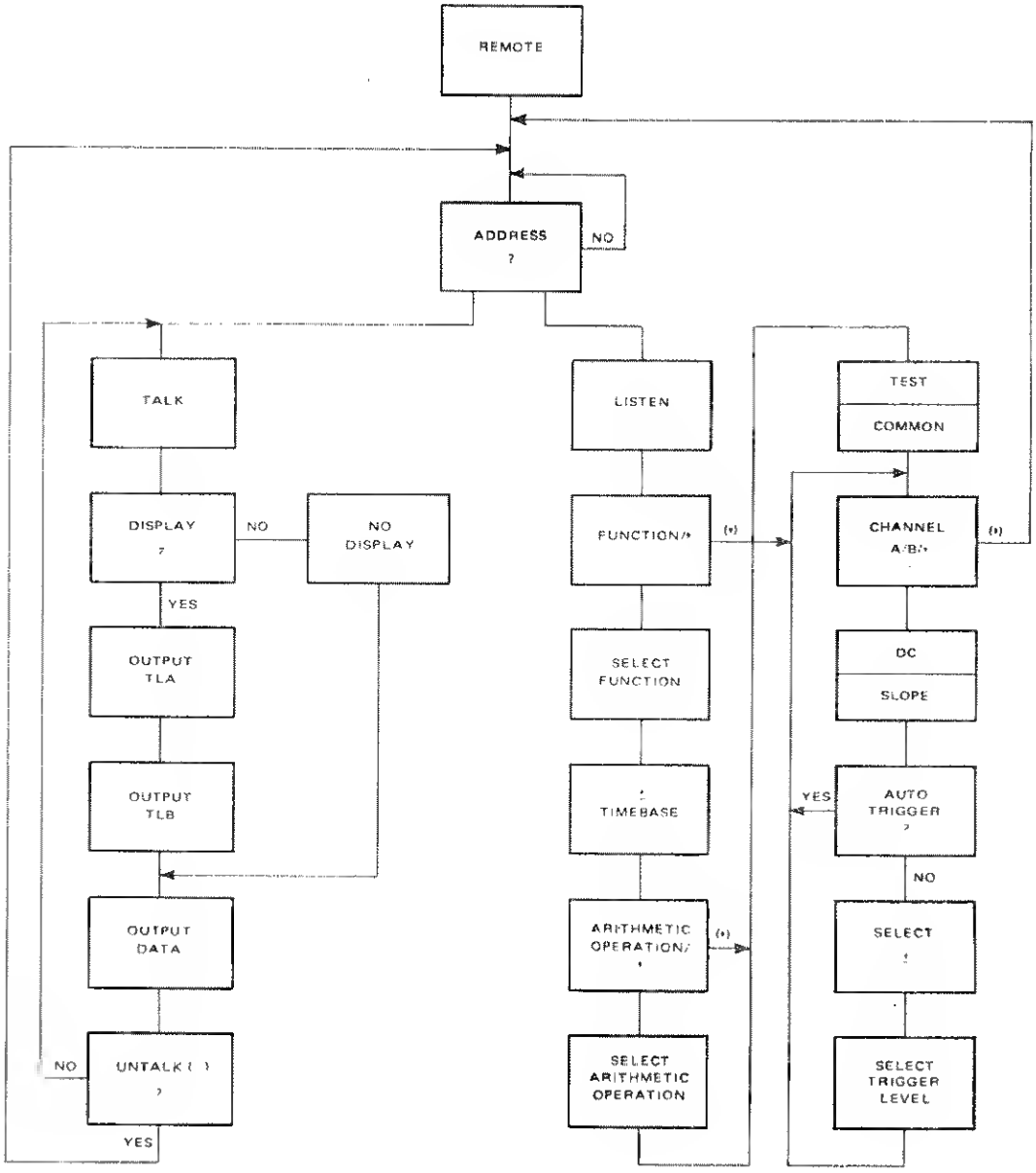


Table 3.7 - Option 55 Software Flow Chart #1

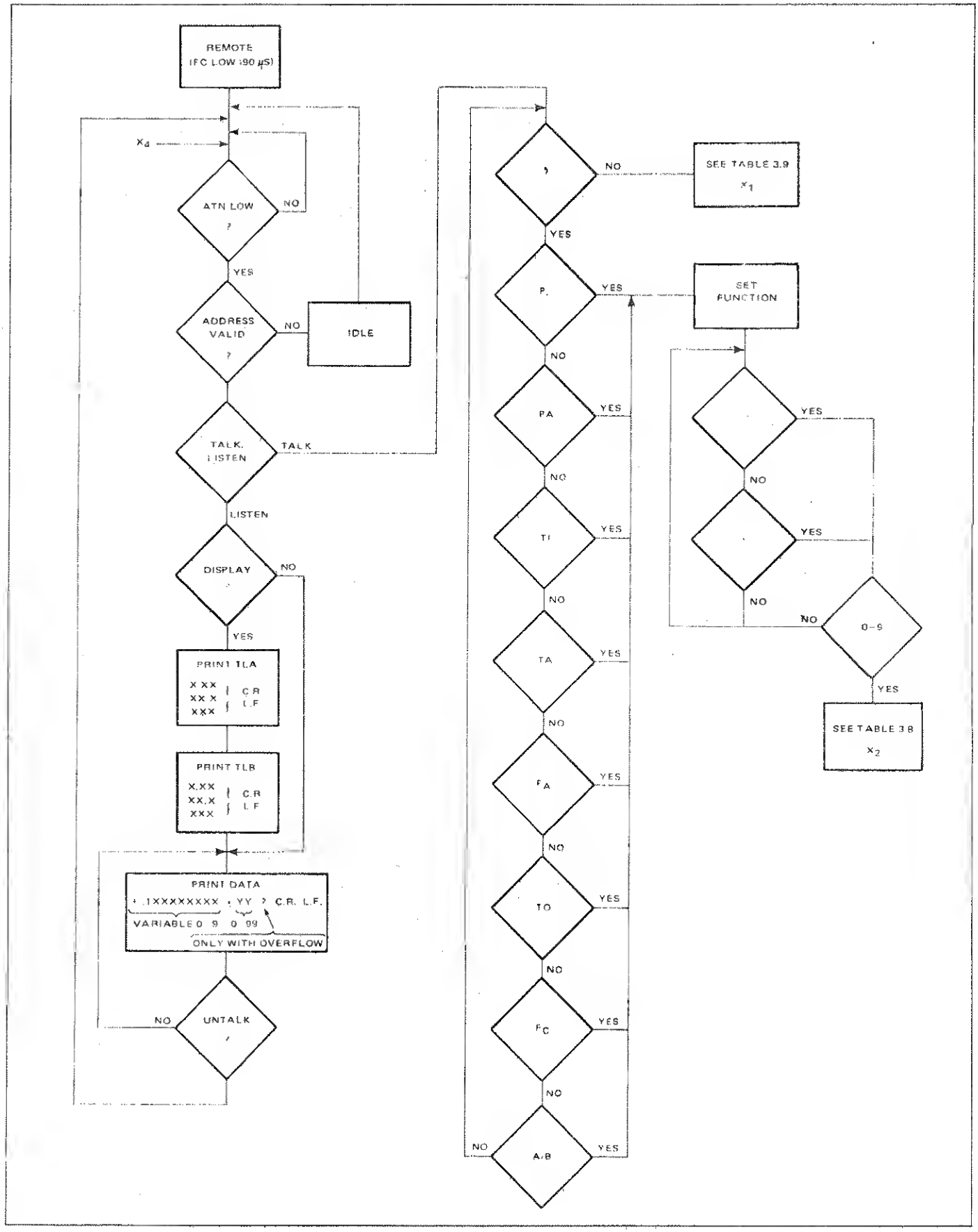


Table 3.8 - Option 55 Software Flow Chart #2

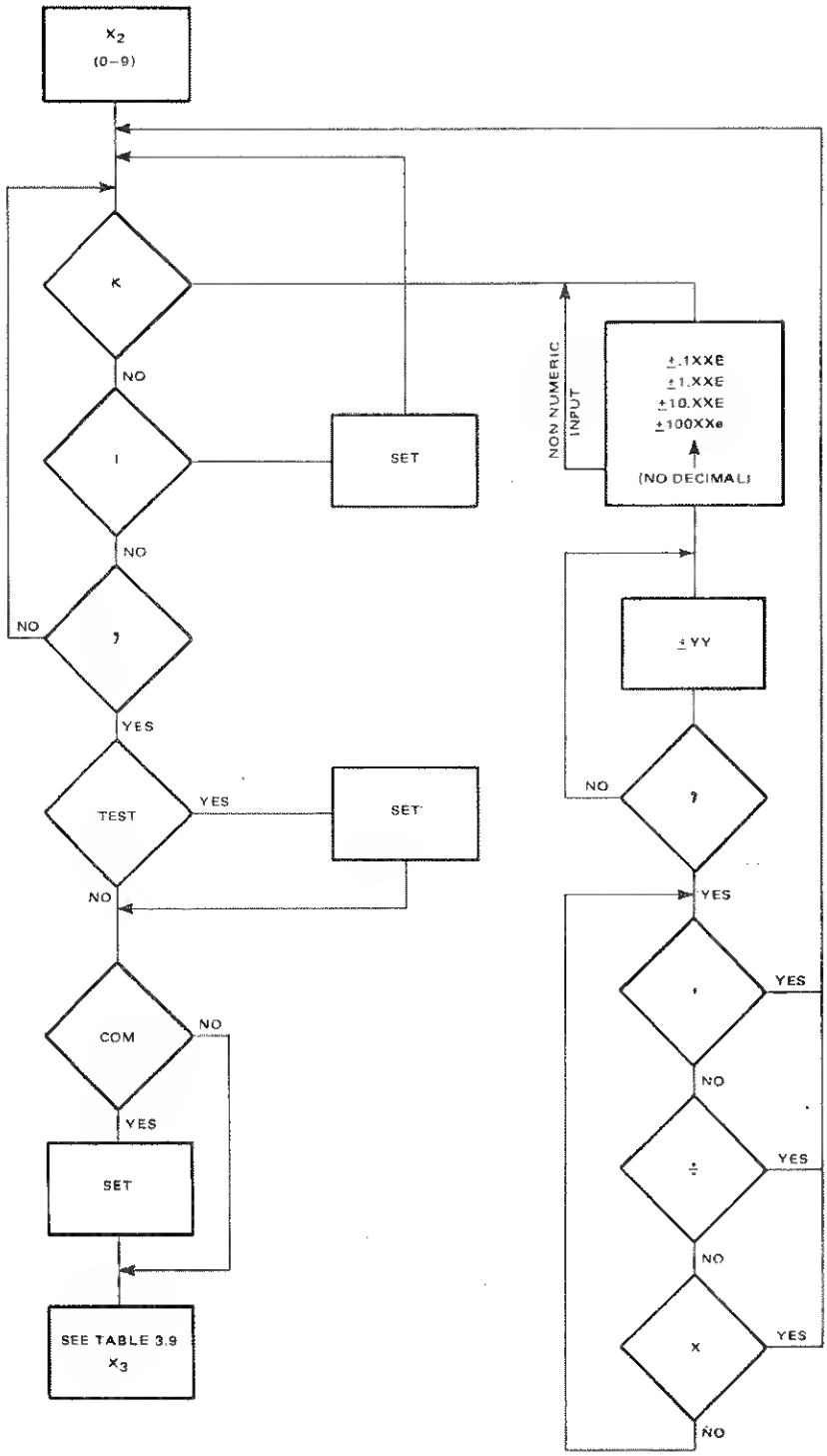


Table 3.9 - Option 55 Software Flow Chart # 3

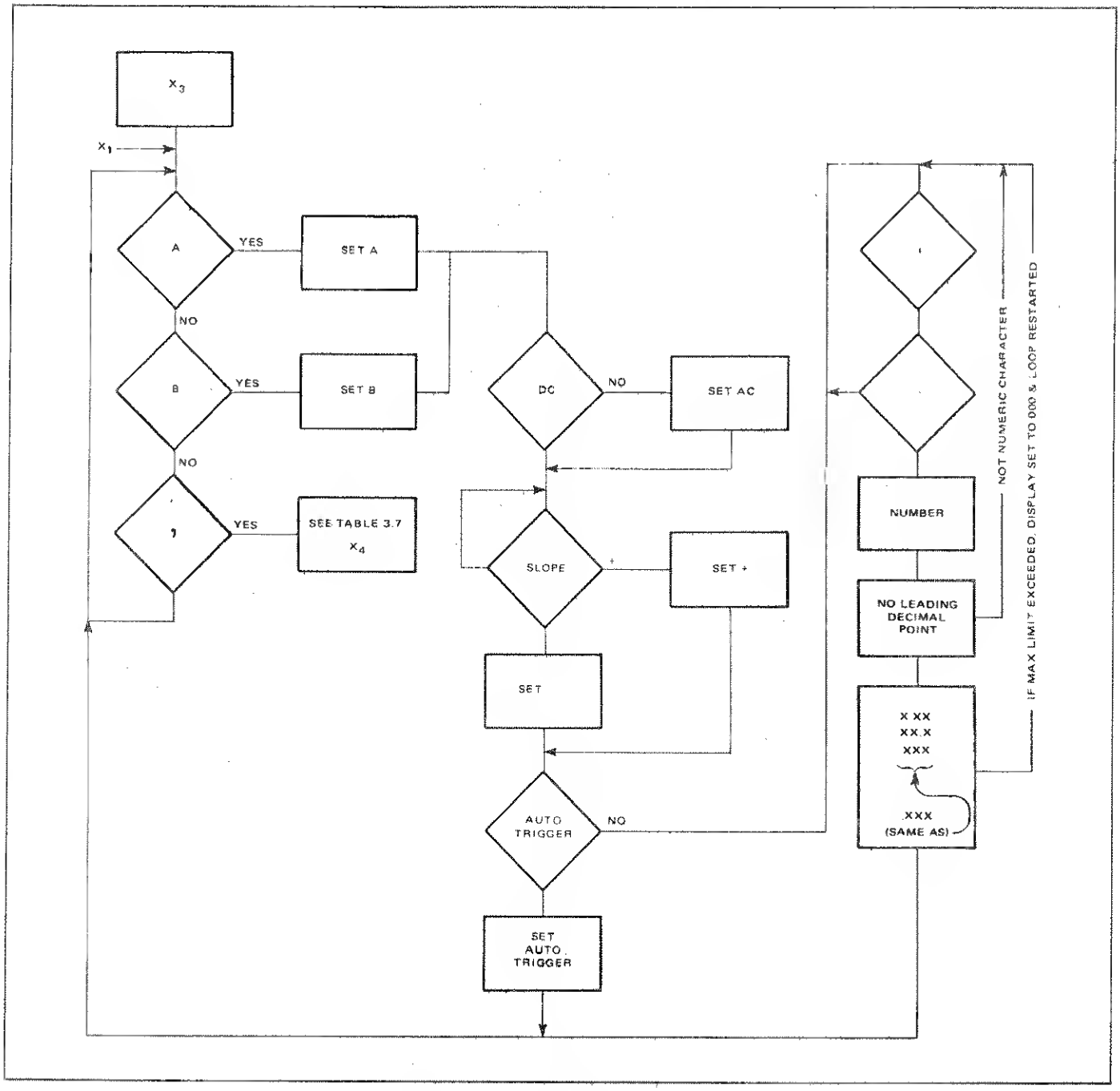


Table 3.10 - Option 55 Printer Operation

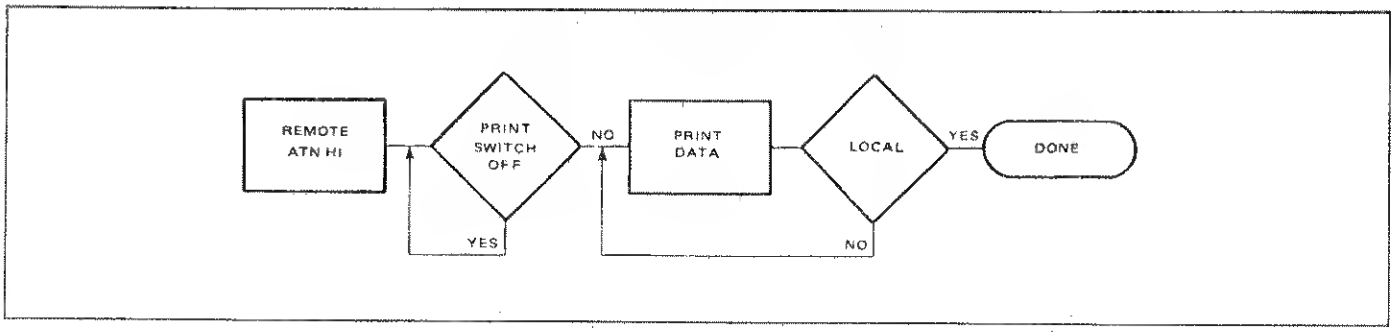


Table 3.11 - Option 11 Software Block Diagram (Option 55)

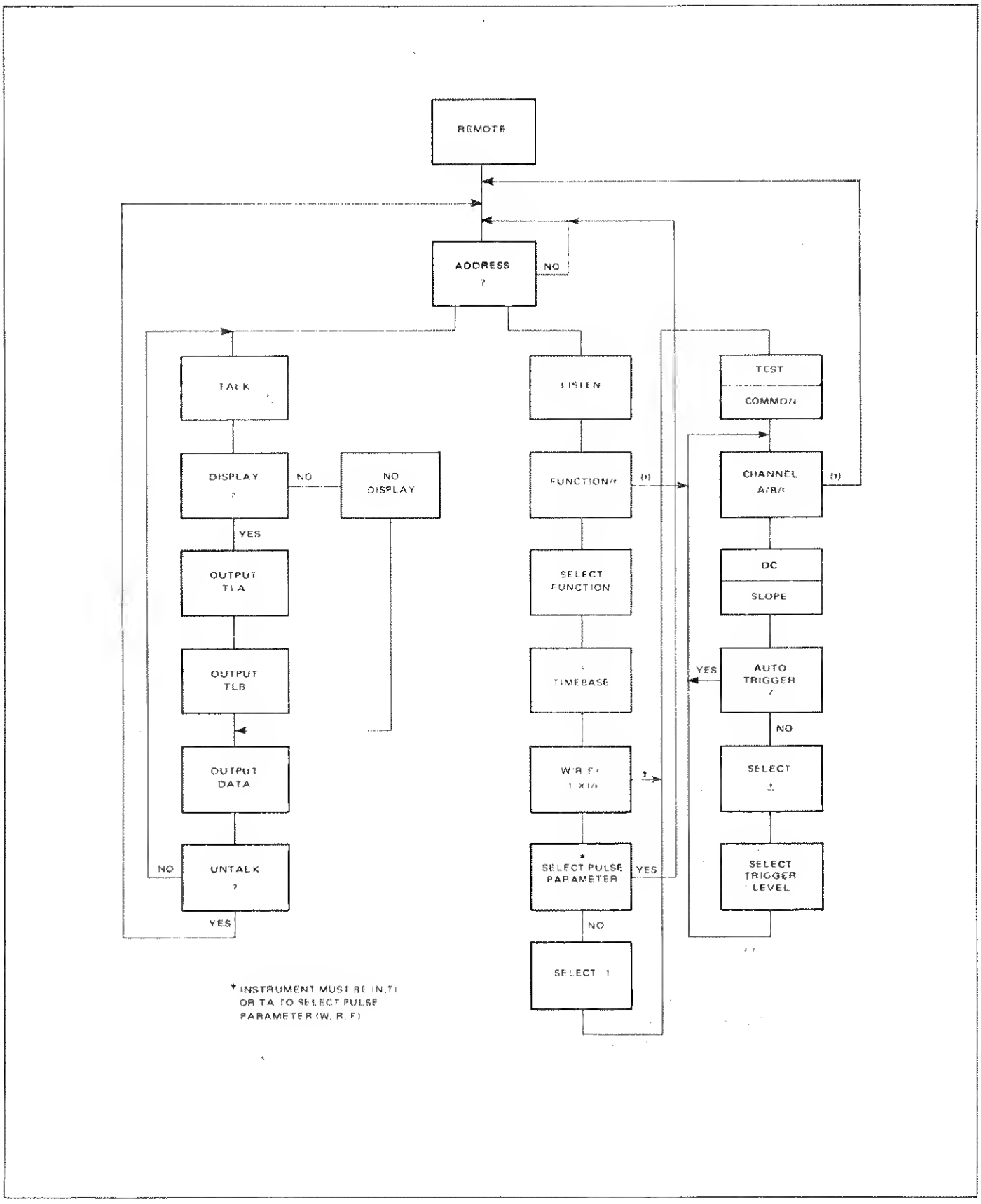


Table 3.12 - Option 11 Flow Chart #1 (Option 55)

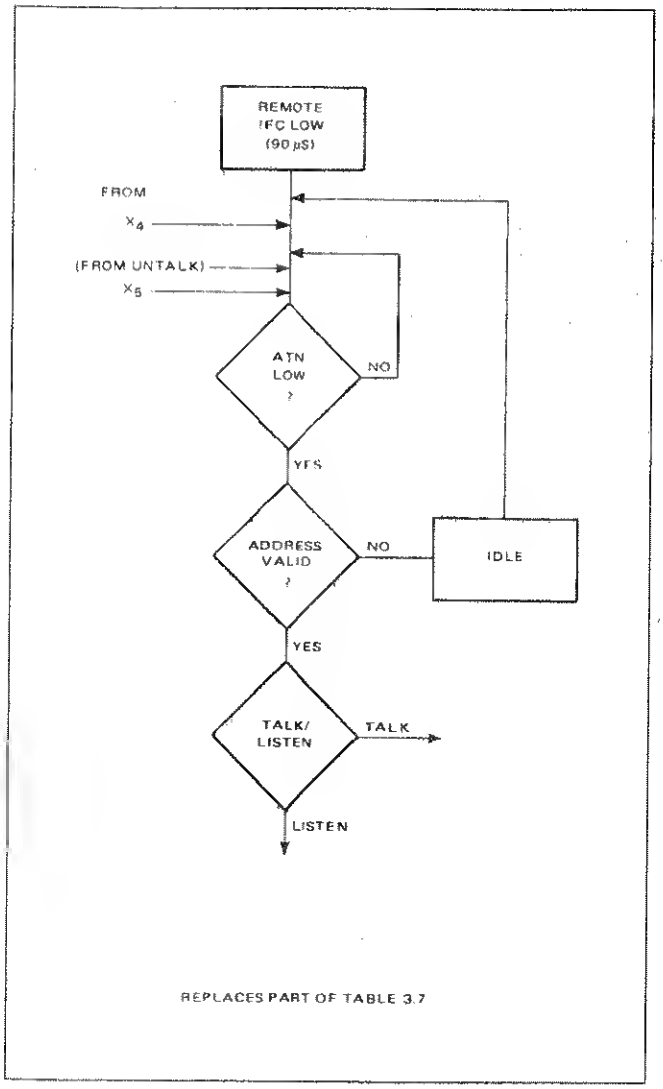
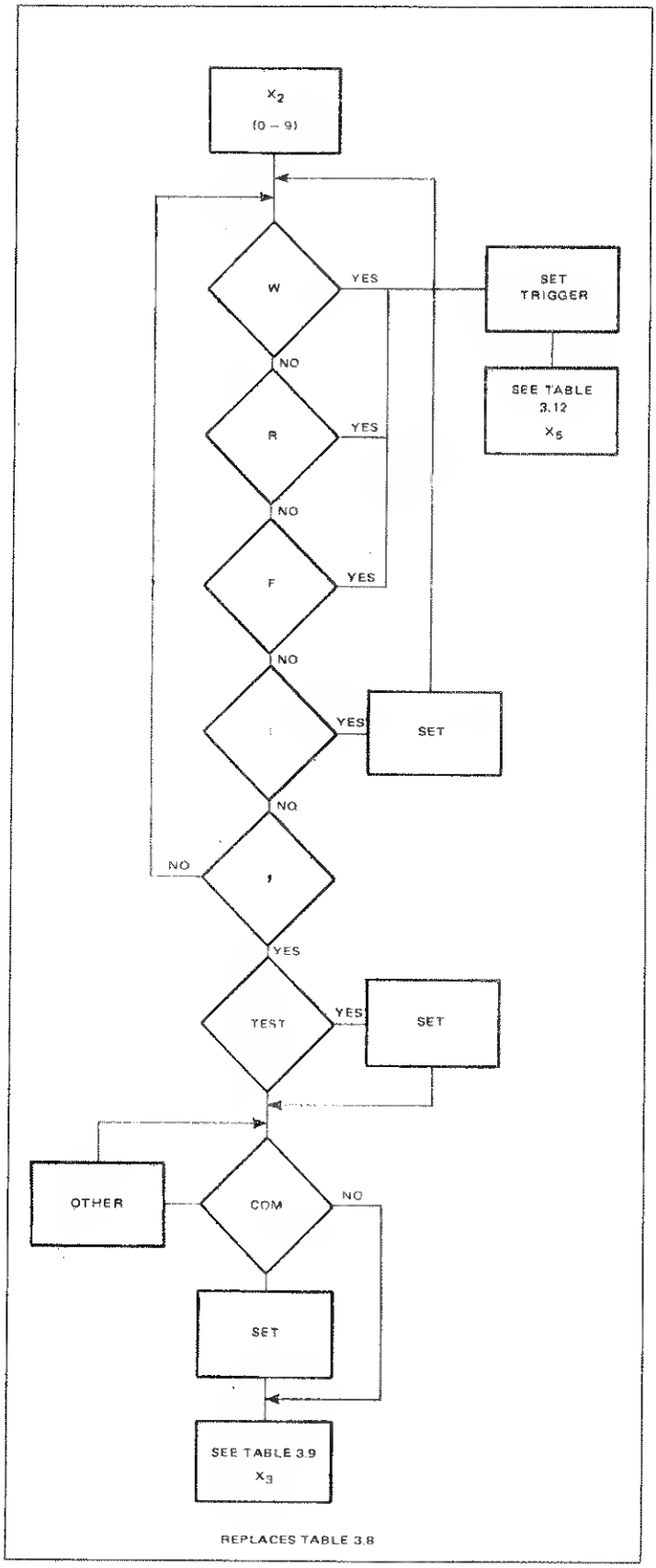


Table 3.13 - Option 11 Flow Chart #2 (Option 55)



3.11 OPTION 57 SERIAL ASCII INTERFACE.

3.11.1 The option 57 provides programming of all keyboard input and data output of all front panel indicators in the form of serial ASCII. The option 57 is specifically designed to interface with TTY terminals and Modems and can be connected to terminals wired to TTL IN/OUT, 20 mA IN/OUT (self-powered), and RS232 IN/OUT.

3.11.2 An internal switch (S3) selects BAUD rates of 1200, 110, or external (100 kHz max.). The option 57 permits programming through a Tape Reader and Separate Reader Control lines are available to supply proper reader control.

3.11.3 All option 57 interface connections are through a 25-pin connector shown in table 3.14. Proper wiring for the various TTY modes is shown in figure 3.3.

Table 3.14 - Option 57 Pin Description

Pin	Nomenclature	Description
1	FG	Protective Ground
2	RS-232 Out	Transmitted Data
3	RS-232 In	Received Data
4	RTS	Request to Send ←
5	CTS	Clear to Send ←
6	RTS	Data Set Ready (+5V)
7	Common	Signal Ground (Common Return)
8		
9		
10		
11	20 mA TTY (+) Out	
12		
13		
14	20 mA TTY (–) Out	
15		
16	20 mA TTY (–) In	
17		
18	20 mA TTY (+) In	
19		
20	DTR	Data Terminal Ready (+5V)
21	Reader Control (+) Out	For use with Tape Reader Optical Coupler 10 mA @ 10V max.
22	Reader Control (–) Out	
23		
24	TTL Out	Used for connecting instruments in parallel
25	TTL In	

3.12 BUS.

3.12.1 The option 57 accommodates up to 10 instruments on a single bus (figure 3.4) with each unit having a separate address. The address allows a specific instrument to be "called up" by the TTY or a tape without interfering with any other unit on the bus. The address is selected hy the positioning of four switches on a quad switch unit, located on the serial ASCII board.

3.12.2 The switch code selected represents either a numeric or alphabetic code, 0 through 9 or a corresponding P through Y. The codes are shown in figure 3.5.

3.12.3 If the numeric address is selected, questions relating to each command are generated hy the option; if the alpha address is selected, no questions are generated and the option acts directly on the received data.

3.13 MODES.

3.13.1 The option 57 is equipped with a universal asynchronous receiver/transmitter (UART) permitting two-wire transmission and reception of data with a similarly equipped terminal or computer. To accommodate the various system programs and methods, provisions are made on the board (switch S1) to select: parity inhibit, one or two stop bits, word length, and odd or even parity. The switch and position arrangements for various operating setups are shown in figure 3.6.

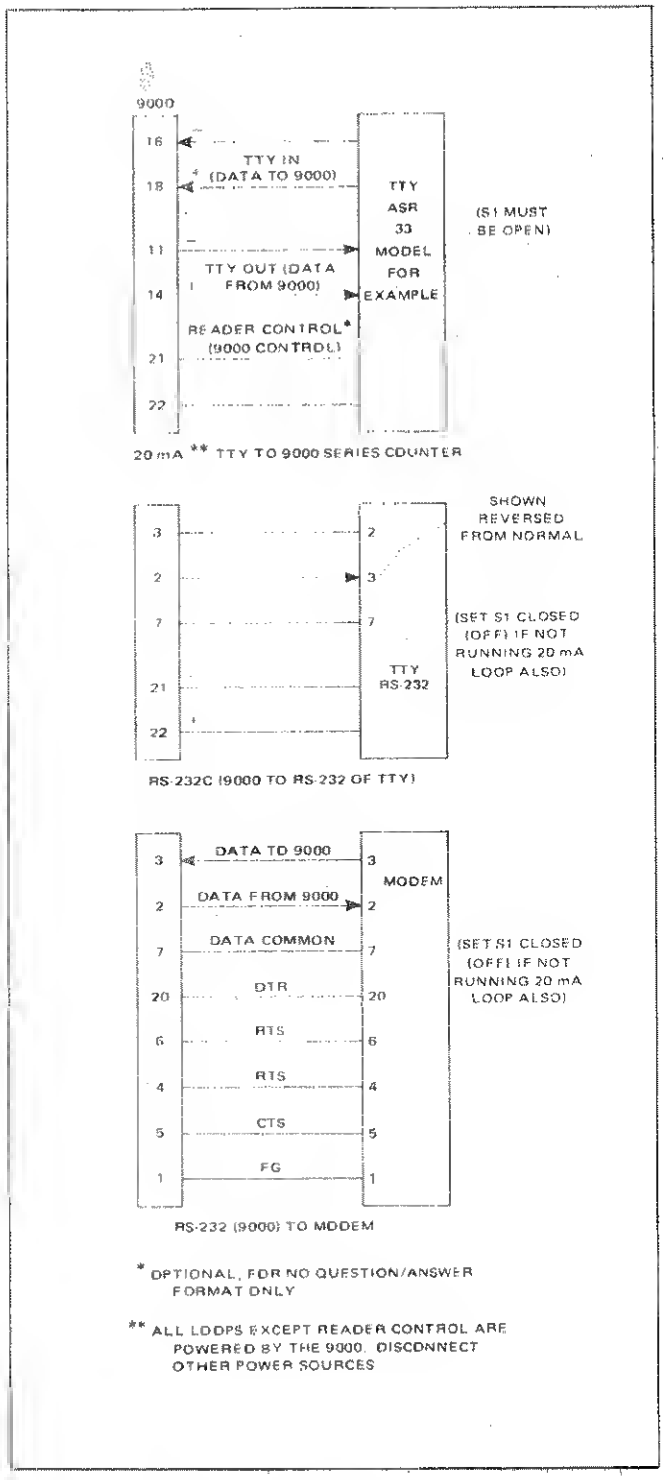


Figure 3.3 - Interface Wiring for TTY Operation

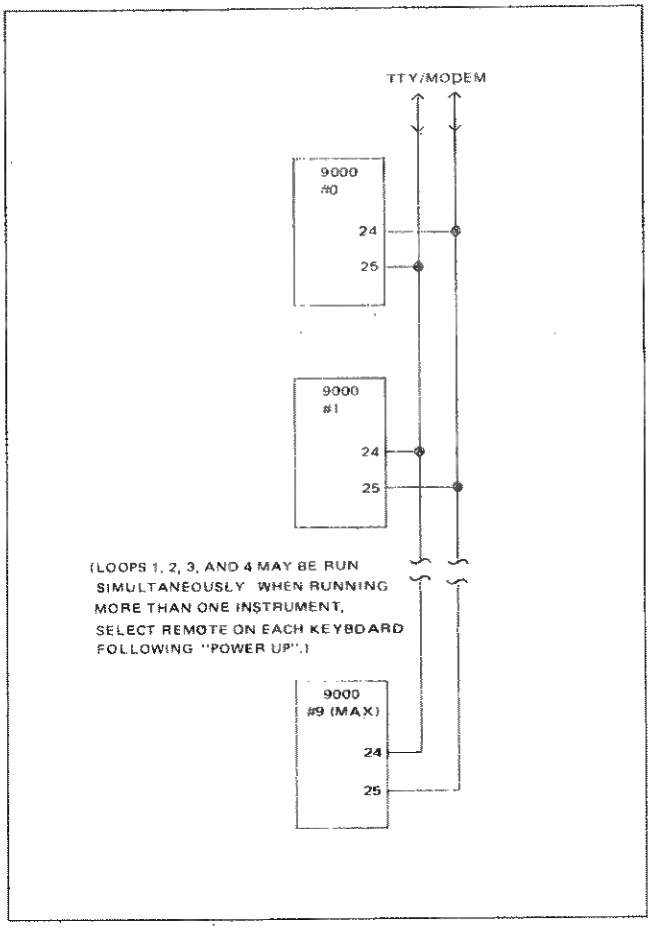


Figure 3.4 - Bus Hookup

3.14 OPERATION.

3.14.1 Prior to operation the switches S1, S2, and S3 on the Interface Serial ASCII board are set to accommodate the users needs. When shipped, the switches are set for TTY operation as shown below.

S1	S2	S3
C, A, B, D, E, TTY } OFF	110	A_3, A_2, A_1, A_0 } 0/P

3.14.2 Operation from a remote terminal consists of a two way conversation between the 9000 and the terminal (the 9000 operates in a full duplex mode). With a numeric address used to call up the instrument, the 9000 performs a sequence of questions to which the operator responds to complete the programming cycle. With an alpha address used, the 9000 simply waits for the correct sequence of program data. This sequence is shown in table 3.15. A sample of each type of operation is shown in figure 3.7. In this example, the alpha/numeric address used is 0/P.

Table 3.15 - Option 57 Program Format

Question		Response
DATA?	Y or N	A "NO" will continue A "Y" will print data
FUNCTION?	P CR PA TI TA TO FA FC RA CR	Period CR is carriage return Period Average Time Interval Time Interval Average Totalize Freq A Freq C Ratio's A/B Jumps to Chan
EXP?	± Digit	Enter MULTIPLIER 0 to 9 RESOLUTION −8 to +1 GATE TIME −6 to +1 } Exponent
CONSTANT?	Y or N	N jumps to Chan
NUMBER?	±CR or ±.xxxxxxxE±YY or x.xx or xxx.	If only '1' is desired enter ±CR CR goes to Function
FUNCTION?	I / X + −	Invert Divide Multiply Plus Minus Goes to Constant when done.
Test; COM;	Y or N Y, N or any character	
CHAN?	A or B or CR	CR jumps to DATA
DC?	Y or N	
SLOPE?	+ or −	
AUTO TRIG?	Y or N	

If Yes prints:
NUMBER: 3 digit no. −320 to 319 function of with decimal point.

ATTN setting

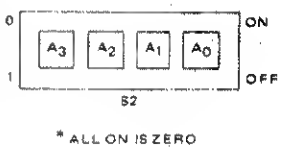
i.e.,	X1	−3.2 to 3.19
	X10	−32 to 31.9
	X100	−320 to 319

If No prints:
TRIG LEVEL: enter ±(3) digits with decimal. Print 3 digits.
CR Terminates entry.

±.xxxxxxE±YY format
To stop press space bar, wait for end of reading
To interrupt press * key until a 'T' is received
Control will return to the operator for new address

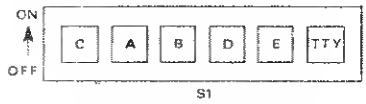
ADDRESSES	0 ⟶ 9	Question Format
	P ⟶ Z	No Question Format

A_3	A_2	A_1	A_0	ADDRESS	
0	0	0	0	0	P
0	0	0	1	1	Q
0	0	1	0	2	R
0	0	1	1	3	S
0	1	0	0	4	T
0	1	0	1	5	U
0	1	1	0	6	V
0	1	1	1	7	W
1	0	0	0	8	X
1	0	0	1	9	Y



* ALL ON IS ZERO

Figure 3.5 - Address Switch Code



(FOR NORMAL TTY OPERATION ALL SWITCHES ARE SET UP ▲)

PARITY INHIBIT	E ON
STOP BITS	D ON (2 BITS) D OFF (1 BIT)
WORD LENGTH	A ON, B ON } 8 BITS A OFF, B ON } 7 BITS
PARITY	C ON EVEN C OFF ODD
TTY	TTY ON
RS 232 IF 20 MA IS NOT USED	TTY ON

Figure 3.6 - Operating Mode Selection

```
T3
DATA?N
FUNCTION?FA
EXP?-2
CONSTANT?Y
NUMBER?+2
FUNCTION?X
CONSTANT?N
TEST?Y
COM?N
CHAN?A
DC?N
SLOPE?-
AUTO ?Y
NUMBER?+3.01
CHAN?
 +.200000E+03
 +.200000E+03
```

```
PNFA-2Y+2
XNYNAN-Y+3.01
 +.200000E+03
 +.200000E+03
 +.200000E+03
 +.200000E+03
 +.200000E+03
 +.200000E+03
 +.200000E+03
```

Figure 3.7 - Data Readout

3.15 SOFTWARE DESCRIPTION (Option 57).

3.15.1 The software defines the sequence of steps that must be followed to correctly program and extract data from the instrument. The software is such that the instrument will accept only those commands compatible with a particular command step, and reject all others. An incorrect command causes the program to "loop" at that point. In the case of a numeric address, the 9000 will continue to repeat the same question until an acceptable response is received.

3.15.2 While outputting data, the data can be stopped if any character is transmitted to the 9000. The data will stop after the transmission of a carriage return, line feed (CR-LF). To start data again another address is sent. This method can be used to synchronize the 9000 to a computer or calculator. To take the 9000 out of the data mode an "*" is sent until a "T" is received - the address is then sent.

APPENDIX A

OPTION 55 EXAMPLES.

Here are a few selected examples of typical programming requirements and the proper sequence for instructing the 9000.

Measure frequency of a 900 Hz oscillator to 3 digit resolution. Use the frequency mode of operation with a one second gate time. The program code string is:

FA + 0, NNAY + Y,

Measure frequency of a 900 Hz oscillator to 9 digit resolution. Use the period average mode of operation, average 1000 periods and invert the measurement. The program code string is:

PA + 3 I, NNAY + Y,

Measure the frequency error of a 900 Hz oscillator to 9 digit resolution. Use the period average mode of operation, average 1000 periods, invert the measurement and subtract 900 from the results. The program code string is:

PA + 3 K – 900, + I, NNAY + Y,

Measure percentage fractional frequency deviation, $\frac{\Delta f}{f}(100)$, of a 900 Hz oscillator to 9 digit resolution. Use the period average mode of operation, average 1000 periods, invert the measurement, subtract 900, divide by 900 and multiply by 100. The program code string is:

PA + 3 K – 900, + K + 900, /K + 100, XI, NNAY + Y,

SECTION 4 THEORY OF OPERATION

4.1 GENERAL.

4.1.1 This section covers the Theory of Operation of the Series 9000 Microprocessing Timer/Counter. The operation is first analyzed in terms of a basic block diagram (figure 4.1); second, the various operating modes are examined; and third, individual circuits are described.

4.1.2 The drawings included in this section are for aiding in the descriptions and are provided as a supplement to the complete schematics located in Section 6.

4.2 BASIC OPERATION.

4.2.1 The Series 9000 is shown in block diagram form in figure 4.1. Referring to this drawing, input signals are processed through the signal conditioner or RF prescaler and fed to the steering synchronizing circuitry. Depending on the function selected, the steering circuitry routes the input signal to the main gate, control logic or the timebase. The synchronizing circuitry is used in the TIA function. The steering logic also routes the output of the timebase to the control logic or the main gate and the 100 MHz output of the reference multiplier to the timebase counters, control logic, or main gate.

4.2.2 Operating instructions are entered through the keyboard. The microprocessor (μP) scans the keyboard and relays the programming information to the program control, which determines the routing through the steering circuitry, controls the control gate logic and sets the timebase frequency division.

4.2.3 The output of the main gate is fed to the accumulator counters, where the number of input pulses are accumulated, and the BCD equivalent of the number of pulses accumulated is transferred to the latch.

4.2.4 The μP strobes the latch and the data in the latch is transferred in serial form to the μP. The latch data, along with the status of the trigger levels, the timebase setting, the scale of the display, and function selected, is sent in multiplexed form to the display.

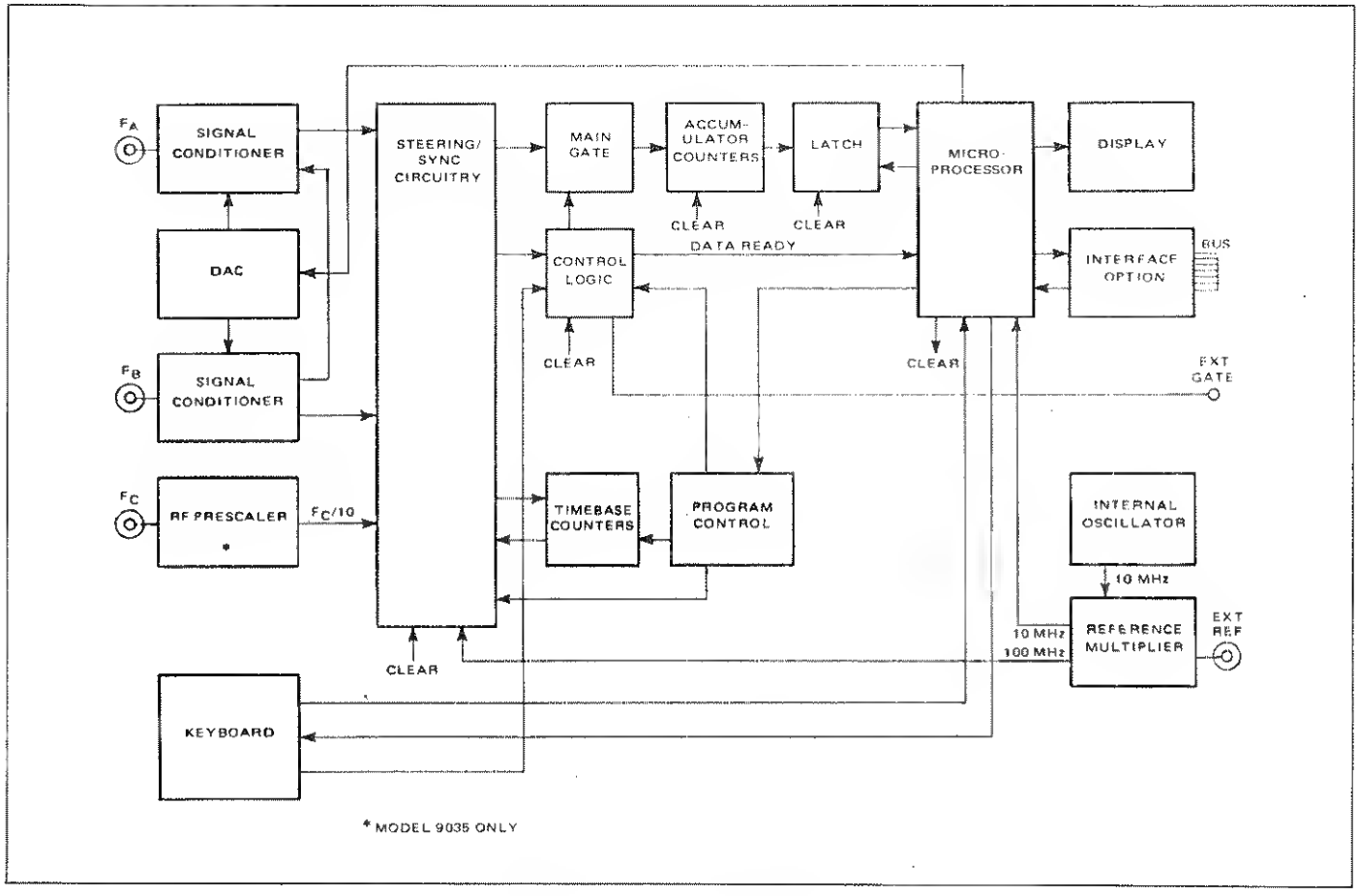


Figure 4.1 - 9000 Block Diagram

4.2.5 If arithmetic operations are performed on the measurement, the data is entered through the keyboard and the process takes place entirely within the μP. The resultant is then routed to the display.

4.2.6 The interface option permits control of the instrument by electrical means and provides the data displayed on the front panel in digital form.

4.2.7 The precise sequence by which the 9000 performs a specific measurement or operation varies from one instance to another. However, the overall operation follows a specific operational cycle. This is illustrated in table 4.1.

Table 4.1 - Operational Cycle

Control Signal	Operation	Note
1. $\overline{\text{CLEAR}}$ goes high:	A measurement cycle is performed	Gate Start Gate Stop
2. $\overline{\text{DATA READY}}$ goes low:	Signals μP measurement is complete	—
3. $\overline{\text{UPDATE}}$ goes low, μP generates ACC Clock:	Shift register feeds data to μP	—
4. $\overline{\text{CLEAR}}$ goes low:	Counters and flip-flops are reset	—

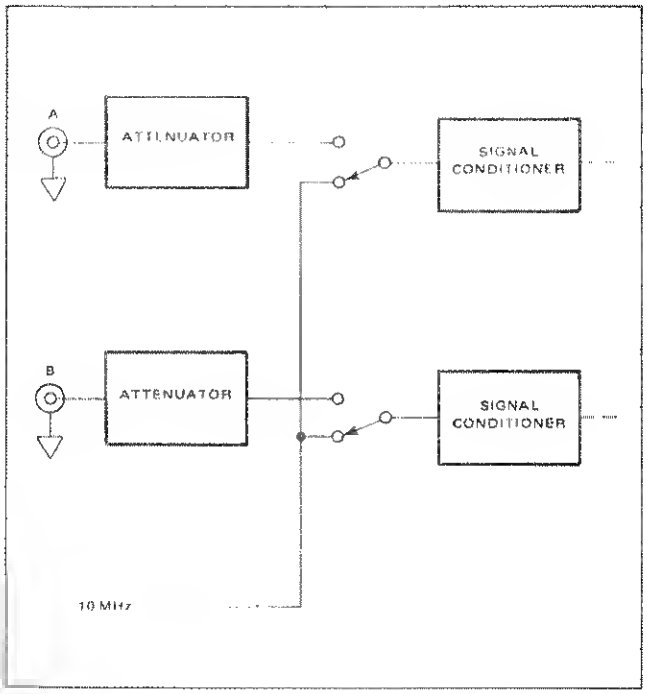


Figure 4.2 - Test

4.3 MEASUREMENT MODES.

4.3.1 The function selected modifies the routing of both the input signal or signals and the reference signal. These differences in instrument operation are described in the following paragraphs. For simplicity in the accompanying figures, the accumulator counters are shown driving the display.

4.3.2 Test.

4.3.2.1 The TEST mode of operation (figure 4.2) enables the operator to check for proper operation of the counter in all operating modes.

4.3.2.2 In this mode the reference signal is used as an input to both channel A and channel B signal conditioning networks.

4.3.3 Period.

4.3.3.1 Period is the inverse of frequency. Therefore, channel A signal is applied to the control logic and the reference signal is connected to the timebase counters (figure 4.3).

4.3.3.2 Clock pulses are derived by dividing down the 100 MHz reference multiplier output. The specific decade division is determined by the setting of the Timebase switches. The output of the Timebase counters is presented

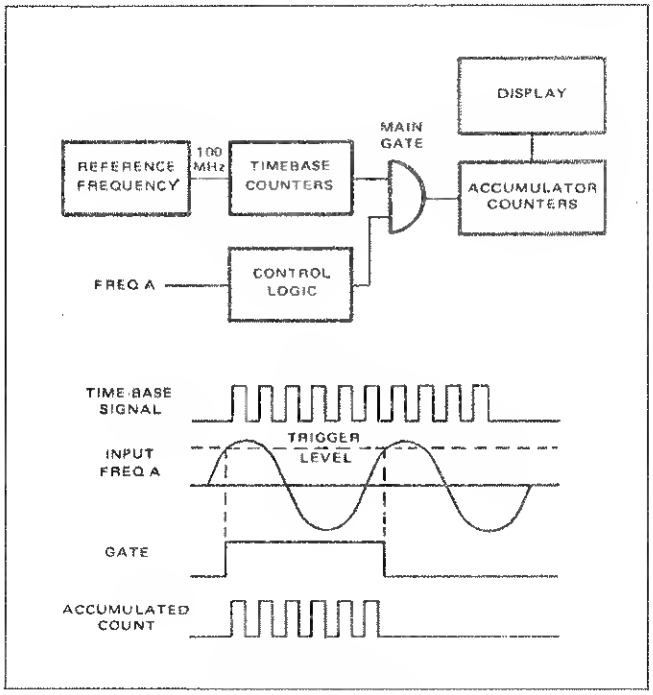


Figure 4.3 - Period

to the input of the accumulator counters. Trigger pulses resulting from two consecutive signals from input A are applied to the control logic. The first trigger pulse opens the main gate; the next pulse closes it. During "gate open" time, the counter counts the applied clock pulses. The count is displayed on the readout directly in microseconds, milliseconds, or seconds, according to the Timebase switch setting.

NOTE

Low frequencies may be determined more accurately by measuring period rather than frequency directly. This is because the longer period of a low frequency allows more counts to accumulate in a period measurement. Therefore, resolution and accuracy are both improved. The 1/X key can then be selected to display the reading directly in frequency.

4.3.4 Period Average.

4.3.4.1 Period Average mode is used to obtain increased resolution and accuracy over period measurements. The more periods over which a signal is averaged, the greater the accuracy of the measurement.

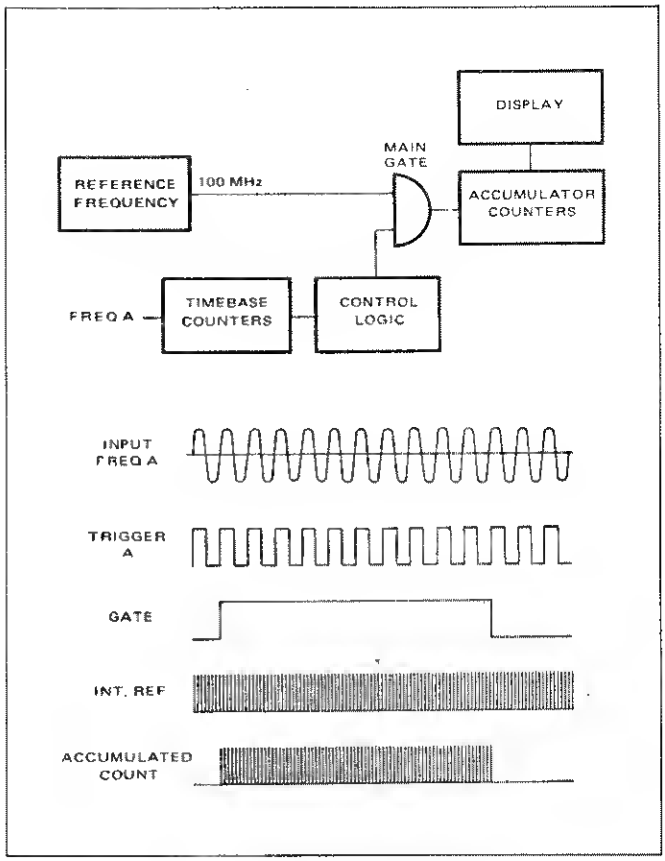


Figure 4.4 - Period Average

4.3.4.2 In this mode of operation (figure 4.4), the reference signal is routed directly to the main gate and the unknown signal is routed through the timebase to the control logic which, in turn, controls the main gate. The pulses occurring during main "gate open" are counted, stored, and an accurate readout measurement is displayed. The "gate open" period is determined by the timebase selected.

4.3.5 Frequency A.

4.3.5.1 During direct frequency measurements, the counter compares the unknown frequency against the known reference frequency (figure 4.5).

4.3.5.2 Channel A input signal is routed to the gate of the counter. The internal reference supplies a 100 MHz signal through the timebase and through the control logic to control the main gate.

4.3.5.3 The number of input pulses accumulated during the "gate open" interval is a measurement of the input frequency. The count obtained is displayed on the readout. This display may be retained until such time as a new sample is ready to be displayed.

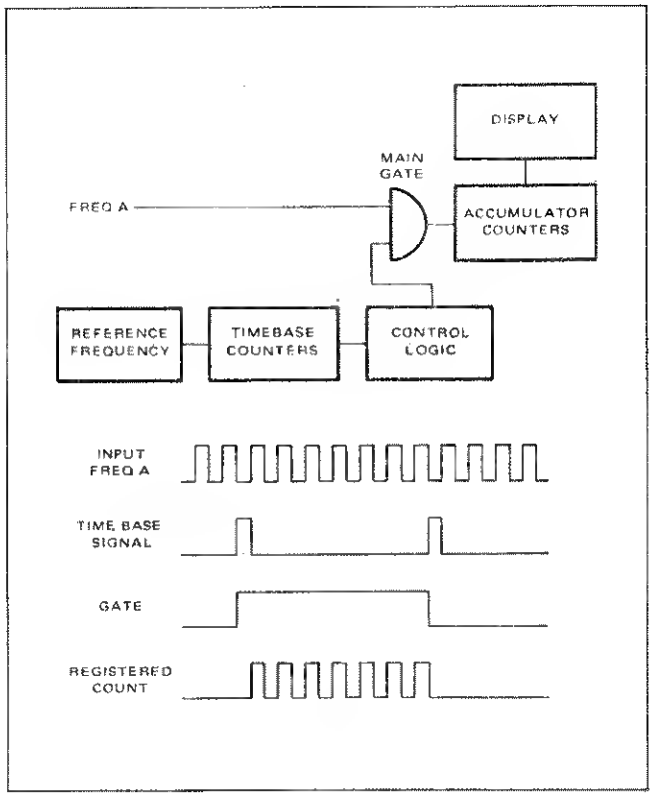


Figure 4.5 - Frequency A

4.3.6 Frequency C (Model 9035 only).

4.3.6.1 In the Frequency C mode, the signal of unknown frequency is applied to the main gate through the prescaler. The prescaler includes an amplifier, automatic gain control circuit, and a divide-by-ten circuit (figure 4.6).

4.3.6.2 The AGC circuit maintains the required amplifier gain which alleviates the need for manual trigger and range control. The divide-by-ten circuit is necessary to reduce the unknown frequency to a frequency which the main counter circuitry can count.

4.3.7 Totalize.

4.3.7.1 In Totalize mode, the main gate is controlled by the manual START/STOP switch on the keyboard or external START/STOP commands (figure 4.7).

4.3.7.2 With the first Start/Stop command, the control logic opens the main gate allowing the input pulses to be totalized by the counter. Assuming no arithmetic computations, the display is updated every 40 milliseconds. The counter readout then represents the input pulses received during the interval between "start" and "stop". External start/stop commands may be applied via the EXT GATE connector.

4.3.7.3 In this mode, the instrument delivers a scaled output frequency to a connector on the rear panel, SCALED OUT. The output is the input signal frequency scaled by 10^N where N is the multiplier setting.

4.3.8 Time Interval.

4.3.8.1 The Time Interval mode of operation allows measurement of the time between two electrical events to a maximum resolution of 10 nanoseconds (figure 4.8). The first event (start) is connected to channel A and opens the gate. The second event (stop) is connected to channel B and closes the gate. These signals control the main gate through the control logic. Slope and trigger level programming allow variable trigger levels on the + or -- slope of the input waveforms. Pulses from the 100 MHz reference circuit are routed to the timebase and to the gate. The pulses occurring during the gate are counted and displayed.

4.3.9 Time Interval Average.

4.3.9.1 Similar to the Time Interval mode of operation, the Time Interval Average mode measures the count

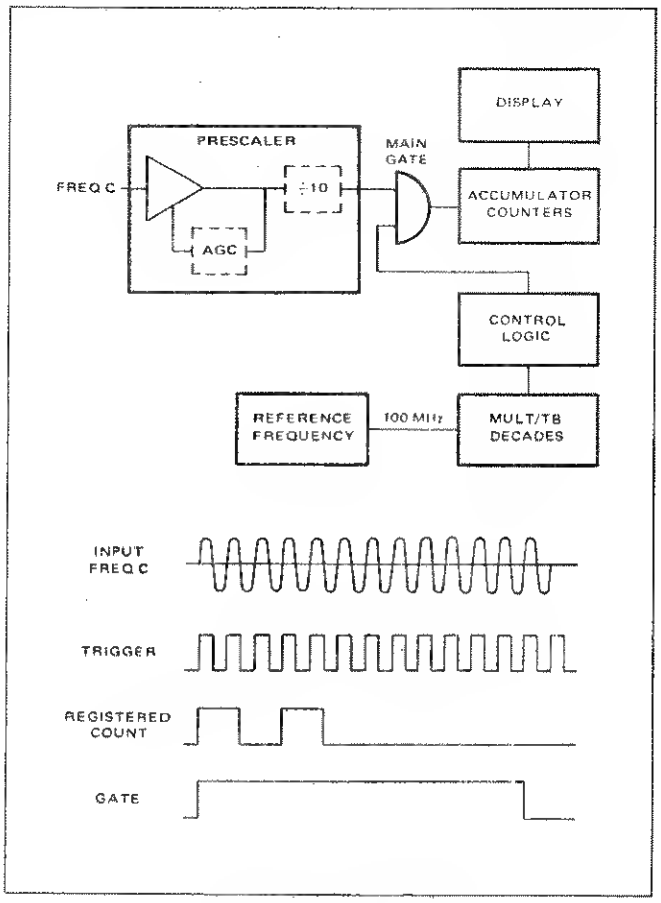


Figure 4.6 - Frequency C

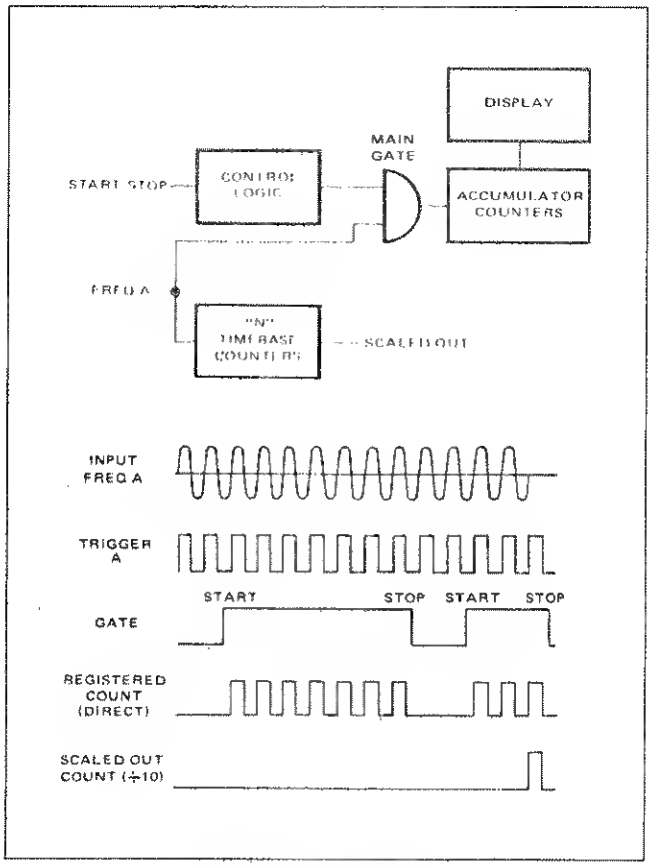


Figure 4.7 - Totalize

accumulated during a multiple of intervals (figure 4.9). It then averages the count by shifting the decimal point and displaying the result. This mode of operation makes it possible to achieve greater resolution and accuracy when measuring time intervals. The A trigger point can follow the B trigger point as close as 50 nanoseconds.

NOTE

In T.I. Average mode, the input signals must be repetitive and asynchronous with the counter's time-base.

4.3.10 A/B (Ratio).

4.3.10.1 This mode is identical in function to the frequency measurement modes, but substitutes an external signal for the reference signal (figure 4.10).

4.3.10.2 The higher of the two frequencies which are to be measured is connected to input A; the lower frequency to input B. Input B is applied to the timebase counters. The higher the timebase selected, the greater the resolution and the longer the measurement time. Two successive positive going edges derived from the timebase counters resulting from input B, open and close the main gate. During the "gate open" interval, the counter counts the trigger pulses derived from input A and the ratio F_a/F_b is then displayed on the readout.

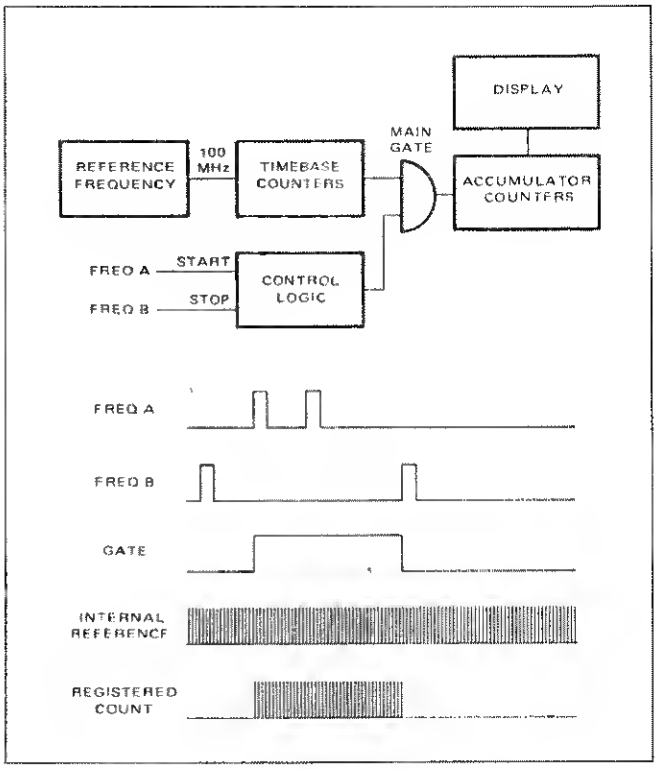


Figure 4.8 - Time Interval

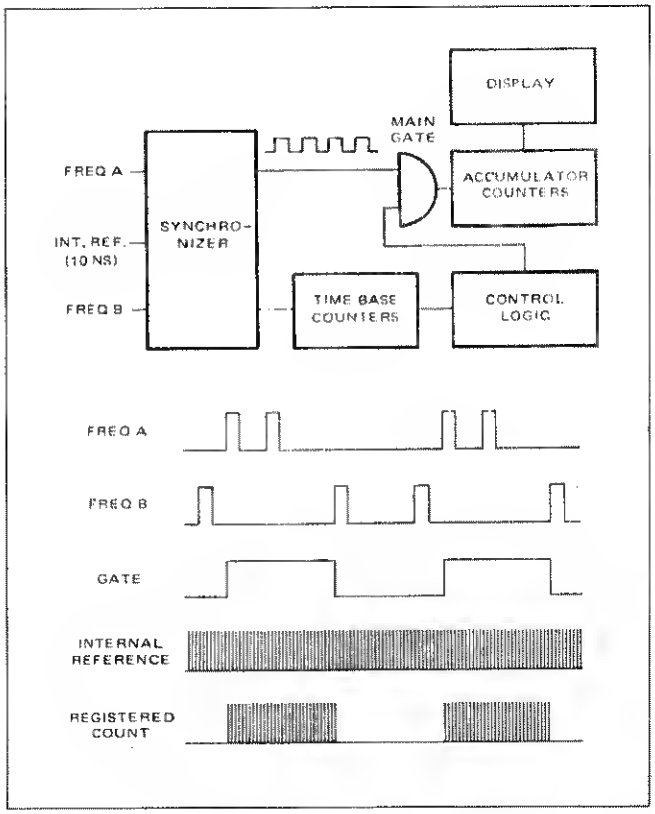


Figure 4.9 - Time Interval Average

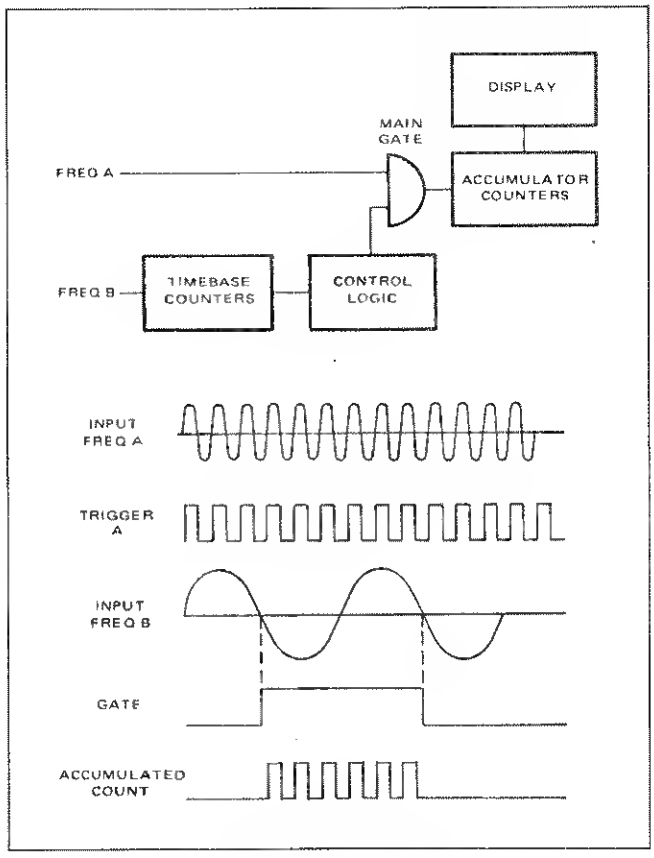


Figure 4.10 - A/B Ratio

4.4 CIRCUIT DESCRIPTION.

4.4.1 The following paragraphs contain descriptions of the circuitry, organized according to the board on which the circuitry is located. The boards with basic signal flow shown between the boards is illustrated in figure 4.11.

4.4.2 Signal Conditioning Modules.

4.4.2.1 The channel A input and channel B input each have identical signal conditioning circuits. The purpose of the circuits is to attenuate, shape, and convert the incoming signal into a squared waveform suitable for the measurement circuitry.

4.4.2.2 For operating convenience, the input to conditioner B can be routed internally from channel A input or channel B input depending on whether COM (common) is selected or not.

4.4.2.3 The conditioner circuitry, shown simplified in figure 4.12, consists of a DC bypass, an attenuator, an amplifier, a Schmitt trigger, a hysteresis compensation circuit, and a slope selection circuit.

4.4.2.4 Referring to the figure, the input signal passes through C1 (or through the relay contact when DC is selected). The signal is then attenuated by a factor of 1, 10, or 100 according to the range selected by relays K2, K3, K4, and K5 as shown in the table.

4.4.2.5 The output of the attenuator is routed to one half of the input of a dual input follower circuit (Q1, Q2, and Q3). The other half of the amplifier input is a trigger reference level and is fed by the output of the digital-to-analog converter (DAC). The dual output of the follower drives the Schmitt trigger.

4.4.2.6 The Schmitt trigger is a limited swing, bi-stable circuit that triggers on the rise and fall portions of the input signal and thereby converts the input into a squared waveform. The level at which the circuit triggers is dependent on the reference input supplied by the DAC and is not equal for both the positive and negative going portion of the input waveform; that is, the circuit displays a fixed amount of hysteresis.

4.4.2.7 For measurements of frequency and period, hysteresis is an advantage in that it reduces false triggering at low amplitude levels; for measurement of time interval and time interval average, however, a means of compensating for the hysteresis is needed.

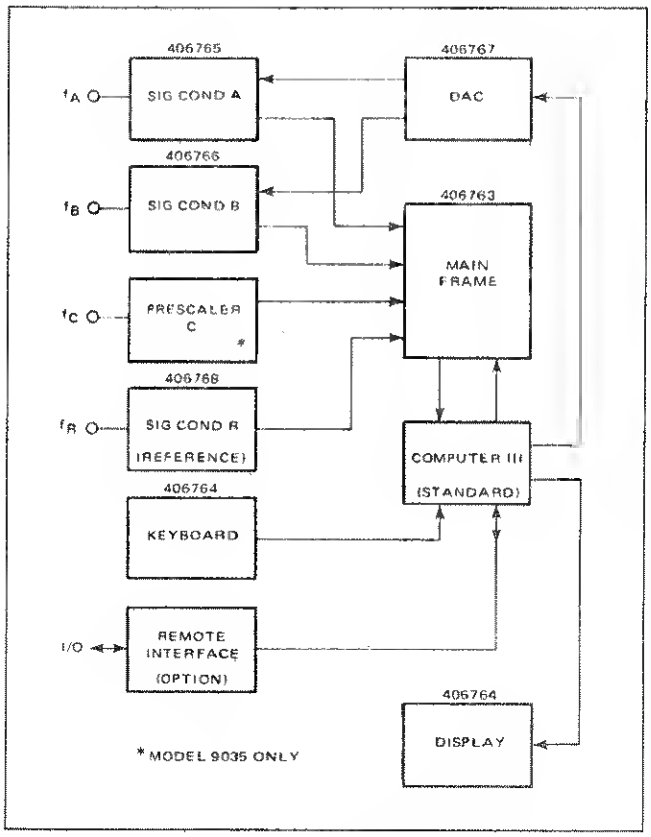


Figure 4.11 - Inter-Board Signal Flow

4.4.2.8 The hysteresis compensation circuit consists of a differential output current source (U1), activated when TI or TIA is selected. The circuit draws a fixed amount of calibrated current from the inverting or non-inverting input circuitry of the Schmitt trigger according to whether + slope is selected or not. The result is to cause the trigger circuit to trigger at the same voltage level on the positive and negative slope of the input signal.

4.4.2.9 The Schmitt trigger produces two squared waveform outputs, one in phase with the input signal and the other 180° out of phase. The slope circuit selects which of the two outputs is routed to the signal conditioning output. The gating consists of diodes CR12 and CR13, biased so that the anodes of the diodes must be positive in respect to the cathodes for the signal to pass through.

4.4.2.10 With + slope at logic True, open collector inverter U1 pulls resistor R51 to common and back biases CR12; the signal flows through CR13 and emitter follower

U2 to the trigger out connector. With + slope at logic false, inverter U1 is not conducting, CR12 is forward biased and open collector inverter U2 pulls R54 down, back biasing CR13. The signal flows through CR12 and emitter follower U2 to the trigger out connector.

4.4.3 Prescaler, F_C (Model 9035 only).

4.4.3.1 This circuitry (figure 4.13) automatically adjusts the amplitude of the channel C input signal to provide a suitable level for the remaining circuitry, divides the input signal frequency by ten, and generates a high, F_C logic signal when an input of the correct frequency range and of sufficient amplitude is applied to the channel C input connector. The circuitry, shown in figure 4.13, consists of an attenuator, RF amplifier, divider, detector, AGC amplifier, trigger circuit, and output signal gate.

4.4.3.2 The attenuator consists of two diodes in series with the input signal flow and three diodes shunting the signal flow. A variable bias voltage, applied in appropriate proportions and supplied by the automatic gain control (AGC), controls the amplitude of the signal that reaches the input of the RF amplifier.

4.4.3.3 The RF amplifier consists of two integrated amplifiers (A1 and A2) operating in series and providing a voltage gain of approximately 100. The amplifier output drives the divider and the AGC circuitry.

4.4.3.4 The divider is a high frequency digital counter capable of operating at near the GHz range. The prescaler divides the frequency output of the amplifier by a factor of 10. The output is controlled by the output signal gate. Scaling is required to reduce the input frequency to a level compatible with the counter circuit.

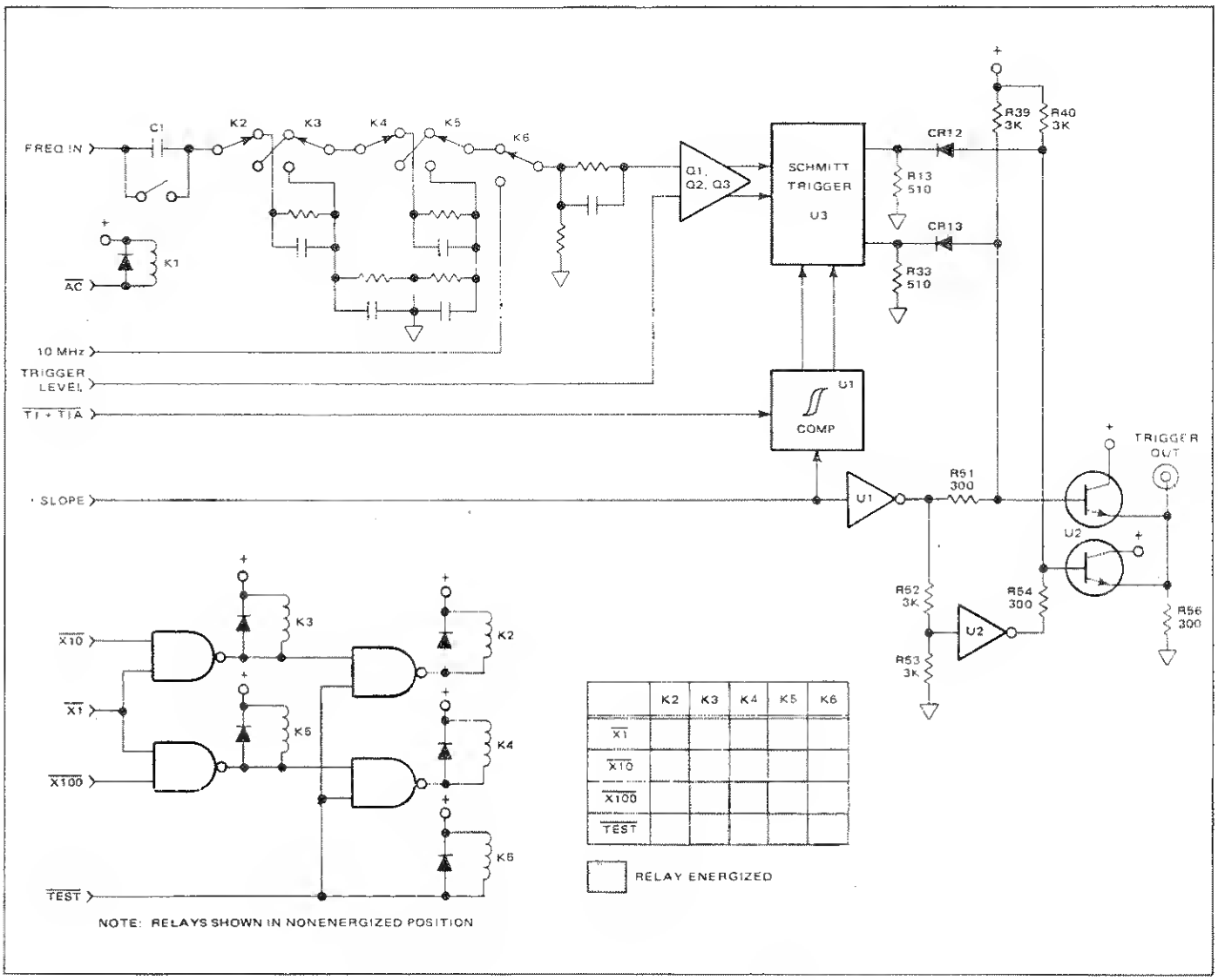


Figure 4.12 - Signal Conditioning Block Diagram

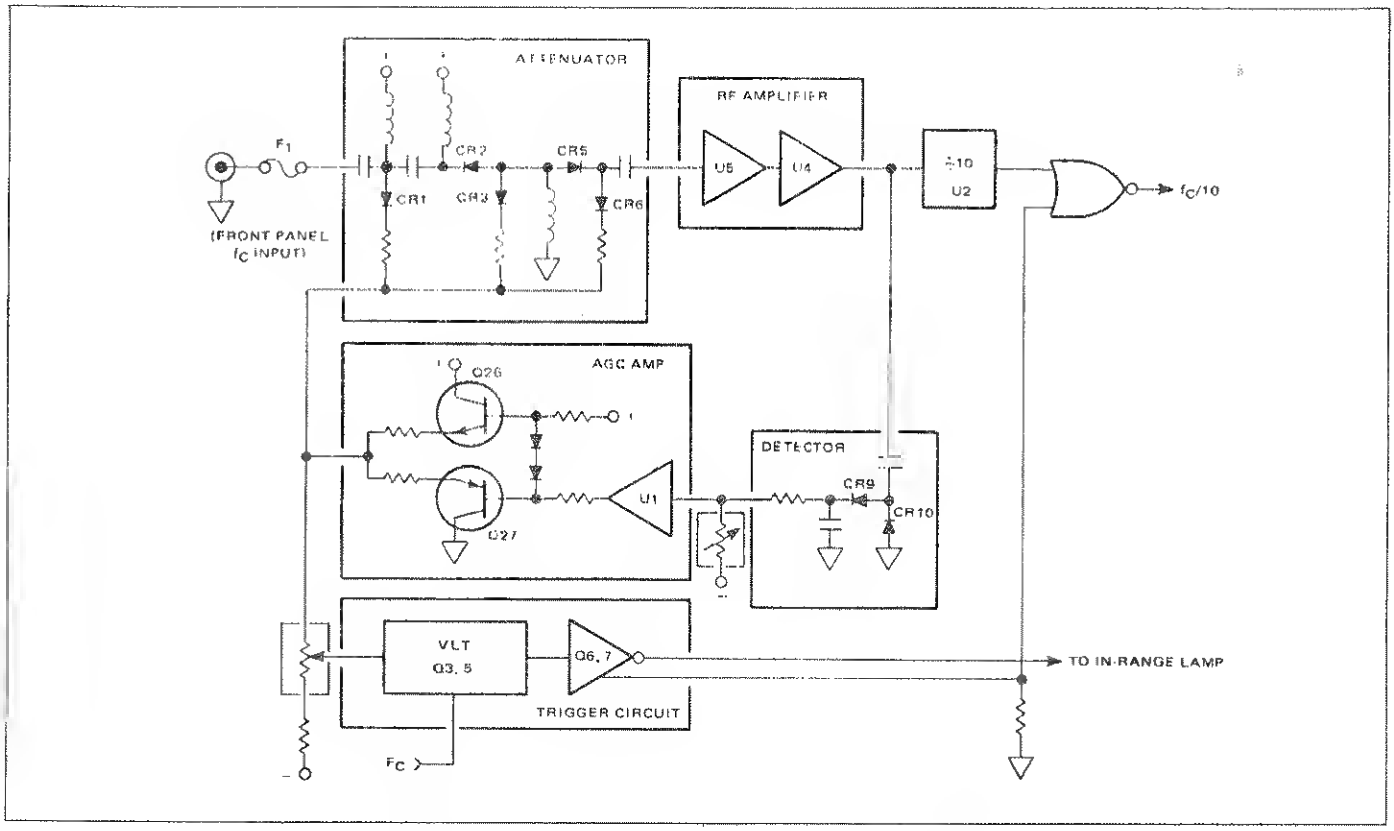


Figure 4.13 - Prescaling Amplifier, F_C (Model 9035 Only)

4.4.3.5 The detector and AGC amplifier generates the operating bias for the input attenuator and provides the input for the trigger circuit. As shown in the figure the AGC feedback path consists of a rectifier CR9, CR10 and an operational amplifier U1, Q26, Q27. The output of the RF amplifier is rectified and filtered to produce a proportional dc level. This dc level is amplified by the AGC amplifier circuitry to provide a control signal having a maximum excursion of from 0 to +10 volts.

4.4.3.6 The trigger circuit monitors the AGC output level and at a predetermined point, produces a logic true output. The circuit is adjusted to produce a true output, when the input signal amplitude is sufficient to operate the counter circuitry. The circuitry is a voltage level trigger and inverter consisting of transistors Q3, Q5, Q6, and Q7. The output lights the front panel IN-RANGE light.

4.4.4 DAC Board.

4.4.4.1 The DAC board generates analog trigger levels for the channel A and B signal conditioning boards. The circuitry on the board is shown in block diagram form in figure 4.14 and consists of two 9-bit shift registers, two 9-bit DACs (digital-to-analog converters), two summing amplifiers, a + reference, and a temperature compensation circuit.

4.4.4.2 The input to the channel A shift register is from ROM 5 of the microprocessor. When a trigger level is selected, the selected value (in digital form) is serially fed to the shift register. At the completion of the transfer of data, the selected value is applied in parallel to the DAC. The DAC converts the digital information into its analog current equivalent. This is converted to a voltage equivalent by the summing amplifier and routed to the Schmitt trigger of the channel A conditioner. The circuitry for the channel B trigger level generating circuitry operates in the same manner.

4.4.4.3 Each 9-bit shift register consists of an 8-bit shift register and a D type flip-flop wired in series. Each DAC consists of an 8-bit DAC, generating a current output of from 0 to 1.992 mA. A 9th bit, corresponding to the most significant bit provides a current of 2 mA when selected. The summing amplifier totals the input currents and converts the current to a comparable voltage level.

4.4.4.4 The + reference is derived from a portion of a transistor array, using two transistors as forward biased diodes in series with a transistor used as a back biased diode. The array provides a voltage drop of approximately 8 volts. This level is buffered by an operational amplifier (U7) wired in a gain of one configuration. The + reference

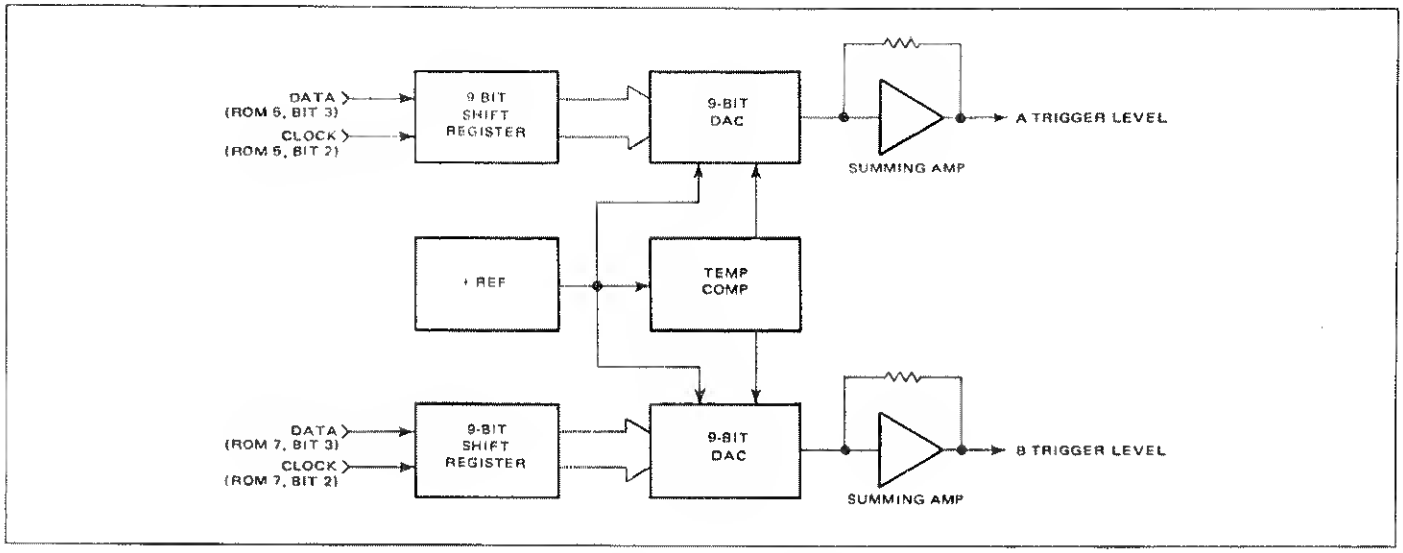


Figure 4.14 - DAC Board

is used by the 8-bit DACs, the MSB current generators and the temperature compensation circuitry.

4.4.4.5 The temperature compensation circuit consists of a voltage divider with two PNP transistors (Q2 and Q3) wired as diodes in series with the divider string. The divider output is used to set the voltage level for the bases of the MSB current generators. The temperature coefficient of the divider tracks with the current generators, making the MSB relatively temperature insensitive across the operating temperature scale.

4.4.5 Reference Multiplier Circuit.

4.4.5.1 The reference multiplier circuit converts the internal reference oscillator (10 MHz) or an external reference (1, 5, or 10 MHz) to a 100 MHz reference signal, used as the timing standard for all measurement functions except A/B and TOTALIZE.

4.4.5.2 The circuitry, shown in block form in figure 4.15, consists of a signal shaping circuit, 10 MHz filter, signal detect/gate circuit, a 5 times frequency multiplier, a frequency doubler, a buffer and a drive circuit.

4.4.5.3 The signal shaping circuit and the 10 MHz filter are in operation only when an external reference is used. With an external reference of 1 volt RMS (−0, +50%) at 1 MHz, 5 MHz, or 10 MHz applied, the signal shaping circuit converts the input into a squarewave of the same frequency. The shaping circuit consists of an inverter, biased to operate in the class A mode, driving two inverters, connected as a Schmitt trigger. This drives a standard T^2L logic level inverter, the output of which is fed to the 10 MHz filter.

4.4.5.4 The 10 MHz filter is an active ringing circuit, consisting of transistors Q1, Q2, and 10 MHz crystal Y1. The square wave output of the shaping circuit is differentiated and the negative spikes from the differentiated signal applied to the base of Q1. The emitter of Q1 drives one side of Y1 (operating in the series mode) causing the crystal to ring at 10 MHz. The collector of Q1 in conjunction with capacitor C6 effectively neutralizes case capacitance of the crystal. The output end of the crystal drives Q2 wired as a common emitter, tuned collector amplifier. The 10 MHz output of the filter is applied to the signal detector/gate. The signal detector/gate circuit is controlled by, and when energized routes through the gate, the output of the 10

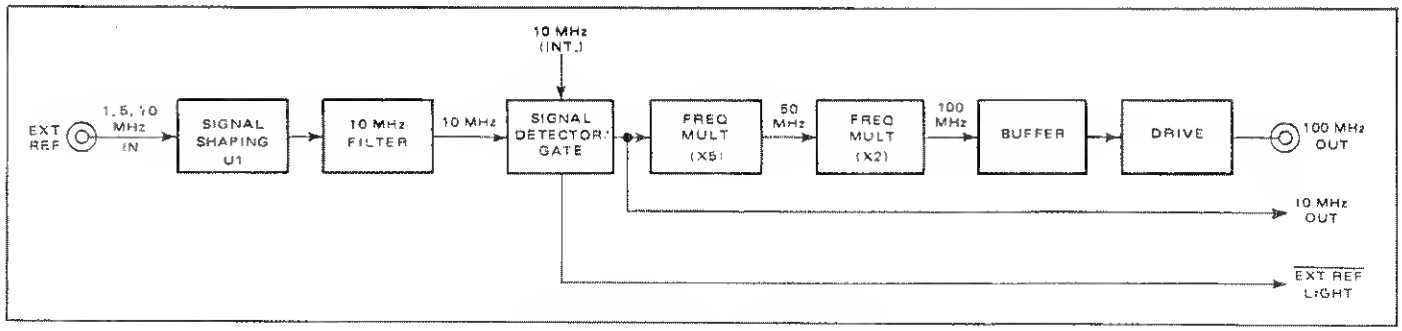


Figure 4.15 - Reference Multiplier Circuit

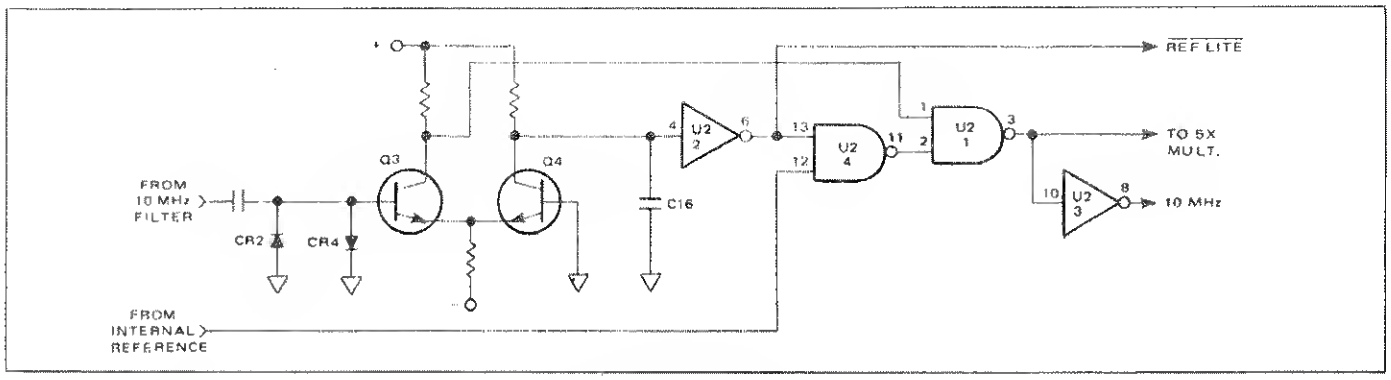


Figure 4.16 - Switch/Gate

MHz filter. In its passive state (no external reference input applied) the gate routes the internal reference oscillator output (10 MHz) through the gate.

4.4.5.5 The gate, shown simplified in figure 4.16, consists of two differentially coupled transistors (Q3 and Q4) and three segments of a quad dual input Nand gate (U2). Because of the additional diode drop (CR4) between ground and the base of Q3, Q3 is biased off and Q4 is biased on when no signal is received from the filter. The logic low output of Q4 is inverted by U2-6 producing a $\overline{\text{REF LITE}}$ logic high (signifying no external reference signal) and biasing U2-13 on, permitting the 10 MHz from the internal reference oscillator to pass through U2-11. The logic high output of Q3 biases U2-1 high, allowing the 10 MHz output of U2-11 to pass through U2-3 to the 5X multiplier. The same signal is inverted by U2-8 and routed to other circuitry and to the rear panel REFERENCE OUT.

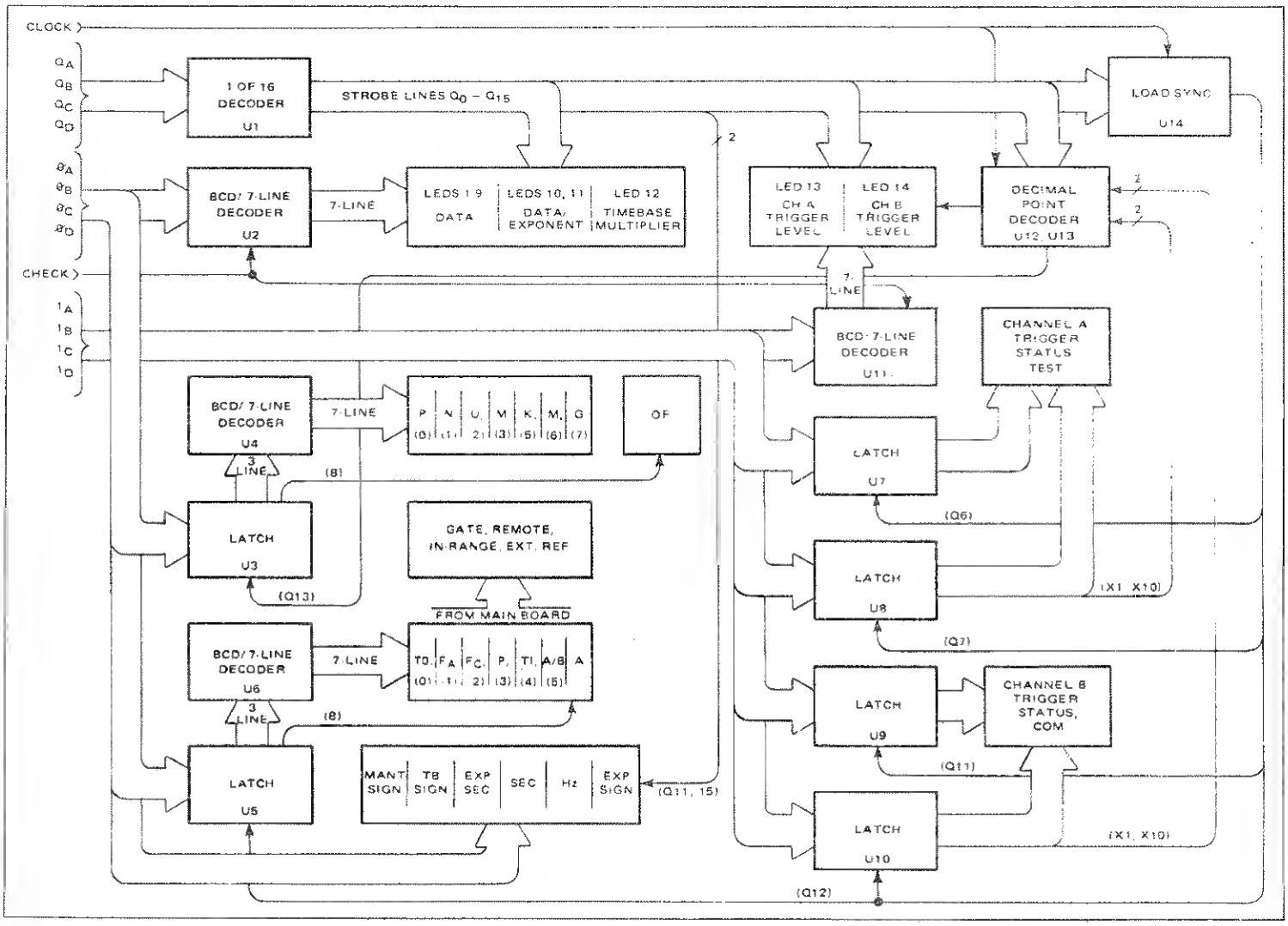


Figure 4.17 - Display Board Block Diagram

4.4.5.6 When a 10 MHz signal is received from the 10 MHz filter circuit, the signal is clipped by CR2 and CR4 and drives the base of Q3. The collector of Q3 is an inverted square wave of the input signal and is applied to one of Nand gate U2-1. The input signal is also coupled through the emitter of Q3, Q4 to the collector of Q4. The signal is integrated by capacitor C16 to produce a logic high which is inverted by U2-6 to produce a logic low on the $\overline{\text{REF LITE}}$ line (the EXT REF lamp on the front panel lights) and inhibits the internal 10 MHz signal from passing through Nand gate U2-11. The output of U2-11 is logic high enabling the 10 MHz signal from the collector of Q3 to pass through U2-3. As in the case of the switch in the passive mode, the 10 MHz from the output of U2-3 is fed to the 5X multiplier and is routed to other circuits in the instrument.

4.4.5.7 The 5X multiplier consists of transistor Q5 and a buffer Q6, Q7. The 10 MHz square wave input from the switch is differentiated through a C/R network and the positive spikes of the differentiated signal drives Q5 on. The collector circuit is tuned to 50 MHz and rings at this frequency. The 50 MHz output is buffered and squared by Q6, Q7 and routed to the frequency doubler. The output of Q7 drives a differential driver (Q9, Q11) driving a push, push doubler consisting of transistors Q8 and Q10. The output circuit is resonant at 100 MHz and the 100 MHz frequency signal from the output is buffered and squared by transistors Q12 and Q13. The output of Q13 is further buffered by emitter follower Q14.

4.4.6 Display Board.

4.4.6.1 The display board, shown in block form in figure 4.17, is mounted directly behind and is in parallel with the instrument front panel. On the board are all of the visual readouts along with the drivers, decoders, latches, and synchronizing circuitry required to control the readouts. Most of the input data for the display board is supplied in multiplex form across 12 lines from the microprocessor board.

4.4.6.2 The data on these lines is in two forms: multiplexed data and encoded strobe lines. The strobe lines are decoded by the 1 of 16 decoder (U1) and the strobe function is provided by the 16 U1 output lines designated Q0 through Q15. The multiplexed data is supplied to the display board over two separate 4-bit busses 0_A - 0_D and 1_A - 1_D.

4.4.7 Computer III.

4.4.7.1 The Computer III is a single printed circuit board occupying locations J7 on the mainframe. Located on the board are the microprocessor (μP), RAMs for the display board and, when the instrument is equipped with an interface option, 6 interface ROMs.

4.4.7.2 *ROM.* Each of the ten ROMs used in the μP have preprogrammed 2048-bit memories (256 x 8-bit words) consisting of programs and data tables, latches and preprogrammed address. Each ROM also has a 4-bit input-output (I/O) port (each port is preprogrammed to be either an input or output port as indicated in figure 4.18) used to route information into and from the data bus lines in and out of the system.

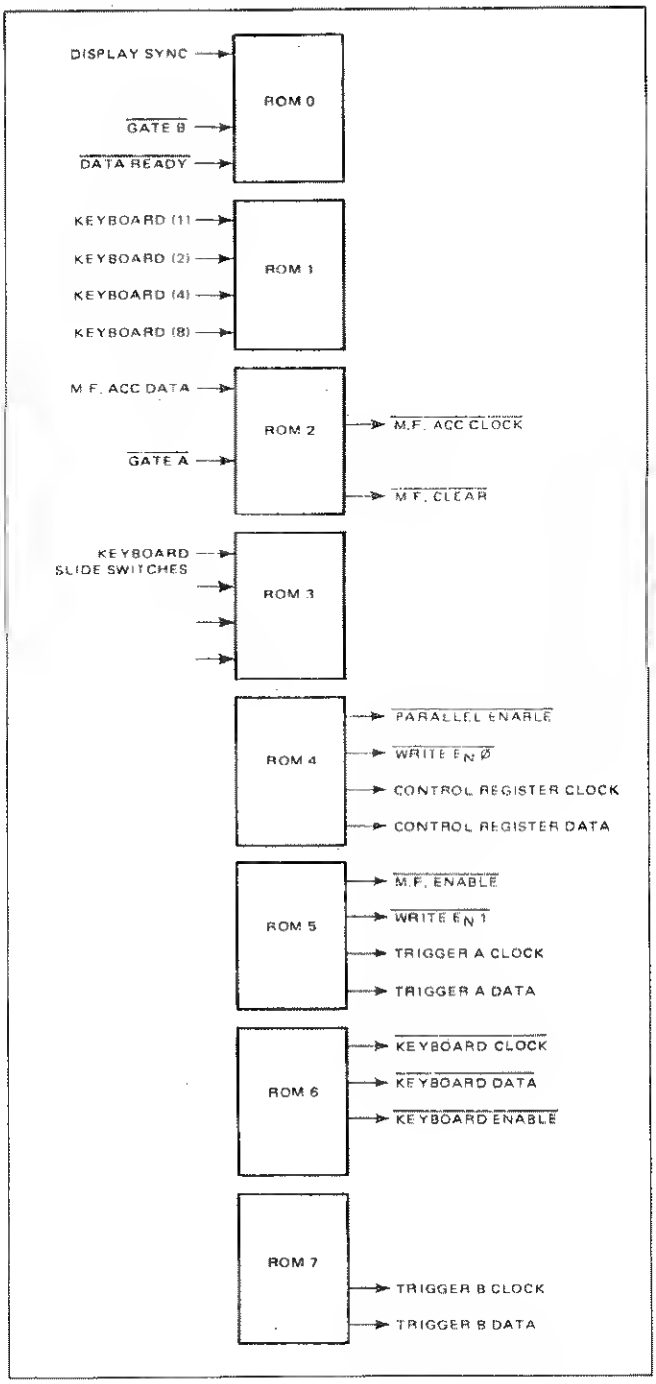


Figure 4.18 - Computer III ROMs (Standard)

4.4.7.3 *RAM.* The two RAMs used as part of the μP are used as a "scratch pad" memory with 4 registers of twenty 4-bit characters, to provide a total of 320 memory bits for each RAM. Each RAM also has 4 output lines which can be used to communicate with peripheral devices.

4.4.7.4 *CPU.* The Central Processing Unit operates in conjunction with the 10 ROMs and 2 RAMs to form a completely self-contained microprocessing system.

4.4.7.5 *Microprocessor.* The microprocessor (μP) is a customized computer in miniature, providing a large variety of control and operational functions in the Series 9000. The μP performs all ranging logic, DAC control, signal routing, arithmetic computation and display control tasks.

4.4.7.5.1 The μP, shown simplified in figure 4.19, consists of a central processor unit (CPU), two 4-bit random access memories (μP RAM), ten 8-bit read only memories (ROM) and a two phase, 715 kHz clock circuit.

4.4.7.5.2 The CPU communicates with the ROMs and RAMs over a 4-bit tri-state bus, through a series of eight synchronous steps. The steps are advanced by the two phase clock and synchronization is made at the first step of the operation through the sync line. The basic steps are: Steps A1, A2, and A3 form an address code for the ten ROMs, all of which are monitoring during this portion of the cycle. Steps A1 and A2 (defining an 8-bit word location within each of the ROMs) are latched into all of the ROMs address memory banks. Step A3 defines the actual ROM being sought. In steps M1 and M2, the 8-bit word from the selected ROM is multiplexed as two 4-bit words and received by the CPU.

Steps	CPU	ROM	RAM
A1	Sends address	Receives address	Idle
A2	Sends address	Receives address	Idle
A3	Sends address	Receives address	Idle
M1	Receives instructions	Sends instructions	Idle
M2	Receives instructions	Sends instructions	Idle
X1	Executes instructions		Idle
X2	Executes instructions		Receives address (or sends out data)
X3	Executes instructions	CPU bus driver enabled	Receives address (or sends out data)

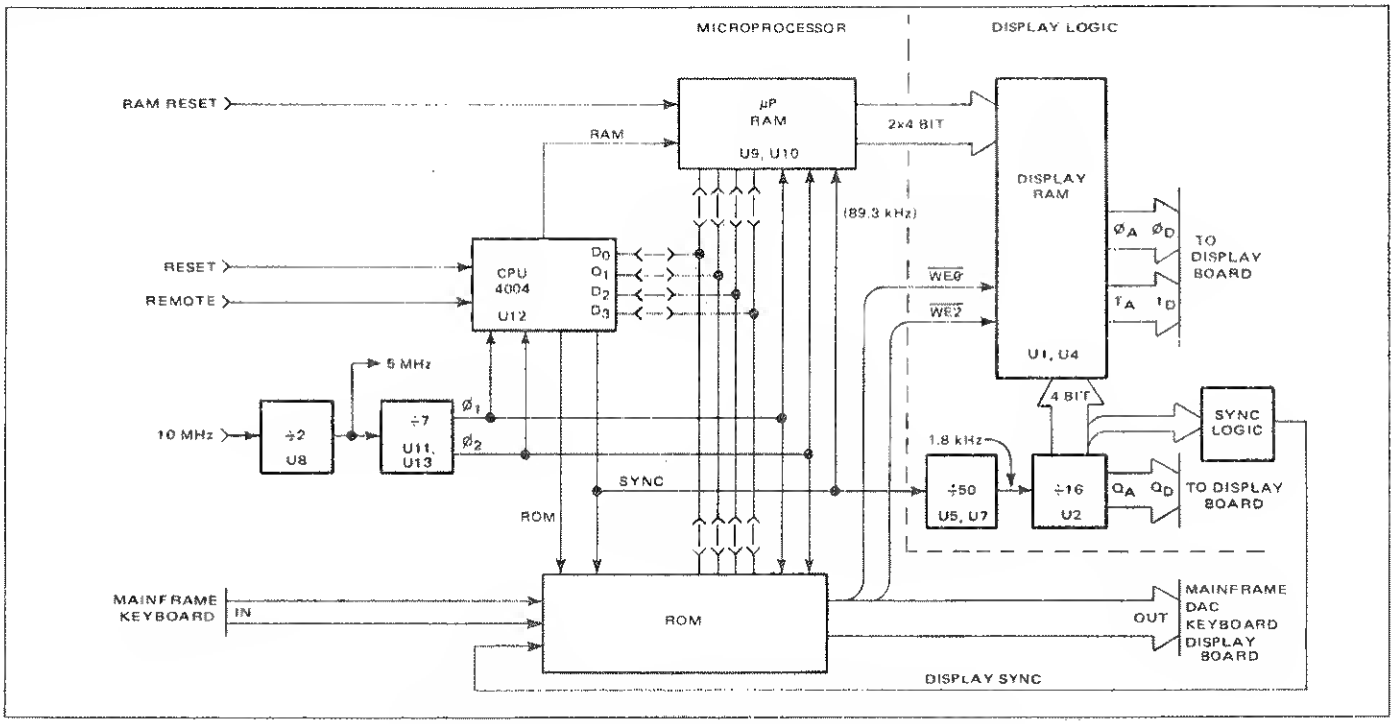


Figure 4.19 - Computer III Microprocessor/Display Logic

Table 4.2 - Display Coding

RAM I OUTPUT

Q	I_D	I_C	I_B	I_A	
15					Trigger Level BCD Coded
14					
13					
12		100	10	1	Channel B
11	COM / SEP		- / +	DC / AC	1/0
10					Trigger Level BCD Coded
9					
8					
7		100	10	1	Channel A
6	TEST	↓ / ↑	- / +	DC / AC	1/0
5					Not Used
4					
3					
2					
1					
0					

FUNCTION CODE

C	B	A	
0	0	0	TO
0	0	1	F_A
0	1	0	F_C
0	1	1	P
1	0	0	TI
1	0	1	A/B
1	1	0	Not
1	1	1	Used

RAM ϕ OUTPUT

Q	ϕ_D	ϕ_C	ϕ_B	ϕ_A	
15	$\overline{\text{Data Sign}}$	$\overline{\text{Timebase Sign}}$	$\overline{\text{SEC (TB)}}$	EXP Sign	
14	D	C	B	A	Timebase Exponent BCD Coded
13	$\overline{\text{OE}}$	C	B	A	Multiplier Code BCD Coded
12	AVG	C	B	A	Function Code BCD Coded
11			$\overline{\text{SEC}}$	$\overline{\text{Hz}}$	
10					Data BCD Coded
9					
8					
7					
6					
5					
4					
3					
2					
1					
0					

MULTIPLIER CODE

C	B	A	
0	0	0	p
0	0	1	n
0	1	0	μ
0	1	1	m
1	0	0	
1	0	1	K
1	1	0	M
1	1	1	G

4.4.7.6 *Display Logic.* The display logic consists of two RAMs (U1 and U4), a divide-by-50 circuit, and a divide-by-16 circuit. The display RAMs store data from the μP RAMs for the display, freeing the μP RAMs for other tasks. Data is fed to each of the display RAMs when the appropriate write enable line is at logic low. The divide-by-50 circuit consists of two decade dividers, U5 and U7. U7 is driven by the sync line from the CPU and drives the divide-by-5 input of U5.

4.4.7.6.1 The output of U5 drives a binary divider which runs continuously producing a binary output count of from 0 through 15. The 4-bit count strobes the two display RAMs and is routed to the display board where it drives the 1 of 16 demultiplexer.

4.4.7.6.2 The data is transferred to the display board by writing into RAM U1, U4. Whenever the need arises to update the display information, the μP senses the start of a new scan by monitoring DISPLAY SYNC and, at the proper time slots, writes the new data in the form indicated by table 4.2. As an example, the following is the "power up" sequence.

a. The instrument is turned on.

b. The internal circuitry automatically selects TI function and 10^{-8} SEC.

c. Data is written into RAM U1, U4. At the same time, this information appears at the output of U1, U4 and is fed to the display logic through lines 0A-0D and 1A-1D.

4.4.7.6.3 As long as no signal input is applied to the instrument and no keyboard entry is made, the display is not updated and reads as follows:

Display:	
Blank	A signal must be supplied, either as described in table 2.2 (T1) or with TEST selected to initiate a new reading for a number to appear in the display.
Function:	
TI	Preprogrammed when power is applied or when Initialize is selected.
Trigger Status (both channels)	
Range:	
100	The trigger levels for both channels A and B are preprogrammed to the 100 range at 000. Slide switch selected controls depend on switch setting.
Coupling:	
(either)	
Slope:	
(either)	
Level:	
000	

4.4.8 **Keyboard.**

4.4.8.1 The keyboard (figure 4.20) consists of 32 pushbuttons, five (5) 2-position slide switches, one (1) 3-position slide switch, a type 4003 static shift register and some diode logic. The keyboard generates all the local control inputs for instrument operation.

4.4.8.2 The Check, Remote, S/S, Initialize, and the Norm/Hold switches are single line command type switches and control circuitry on the mainframe. The remainder of the switches, in conjunction with the shift register, produce multiplexed signals that are fed to the microprocessor.

4.4.8.3 The twenty eight multiplexed pushbutton switches have four output lines (A1, A2, A4, A8) and the five multiplexed switches have four output lines (B1, B2, B4, B8). These lines are checked on a "time share" basis with first the A lines monitored and then the B lines. The procedure is as follows:

Phase One.

a. $\overline{\text{Keyboard Enable}}$ is set high causing all output lines of U1 to be high.

b. If any of the multiplex keys are pressed, a logic high is produced on one of the A output lines.

c. A high level on an A line causes the μP to set $\overline{\text{Keyboard Enable}}$ low, set in a 1, and shift the 1 through the shift register. For example, if AUTO is selected (S28), line A8 goes high when U1 output Q6 goes high. The μP decodes the information and selects AUTO (this selection would require that a Trigger Level command have been previously selected).

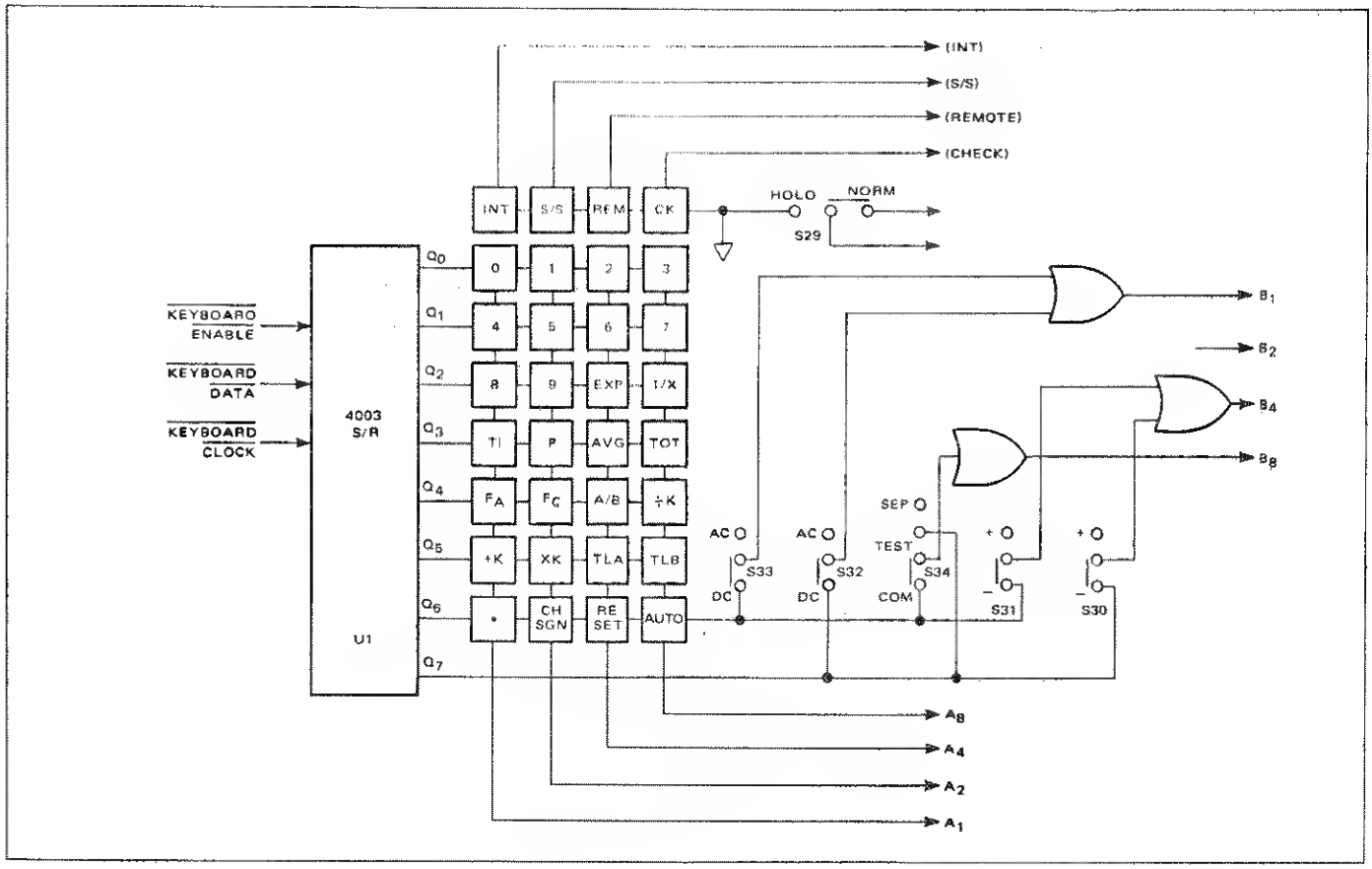


Figure 4.20 - Keyboard

Phase Two.

a. If no button were pushed (as in the previous example), after a given time period the μP strobes lines Q6 and Q7 and reads the positions of the multiplexed slide switches.

4.4.9 Mainframe.

4.4.9.1 The mainframe is the logic and interconnection board of the instrument. On the board is located the accumulator counters, shift register, timebase counters, steering gates, program control, main gate, control logic, synchronizer, marker logic, start/stop circuitry, initialize circuitry, reset logic, and the power supply. The board provides the majority of interconnections between the plug-in boards and contains a large portion of the digital circuitry.

4.4.9.2 *Accumulator Counters.* The accumulator counters count a frequency applied to it and consist of one ECL decade circuit and four T^2L dual decade chips. The BCD output of the counters is fed to the latches. The 8th bit of the most significant decade drives a RS flip-flop which generates the overflow bit. The counter is reset by the clear line.

4.4.9.3 *Latches.* The latches receive the data from the counters in parallel form and store the data until required by the microprocessor. Data is transferred to the latches when $\overline{\text{UPDATE}}$ is false. Data is transferred from the latches to the microprocessor by a pulse train from either the interface ($\overline{\text{INTERFACE ACCUMULATOR CLOCK}}$) or the microprocessor ($\overline{\text{COMPUTER ACCUMULATOR CLOCK}}$), in serial form (ACCUMULATOR DATA).

4.4.9.4 *Timebase Counters.* The timebase counters consist of an ECL decade divider, a T^2L decade divider, a programmable, divide-by-10^N, MOS divider and a D flip-flop. In conjunction with in and out steering gates, the timebase counters can be programmed to divide a frequency routed to it by a factor of 10^0 to 10^9. The D flip-flop is used in all operating modes except the TIA function and provides reclocking of the timebase output.

4.4.9.5 *Main Gate.* The main gate is a dual input ECL NOR gate, one input of which receives the output of the counter steering logic and the other input receives the output of the control logic circuitry. The gate controls the flow of input pulses to the accumulator counter.

4.4.9.6 *Control Logic.* The control logic consists of two T^2L D flip-flops, two ECL D flip-flops, and an assortment of gates and inverters. The control logic generates the gate

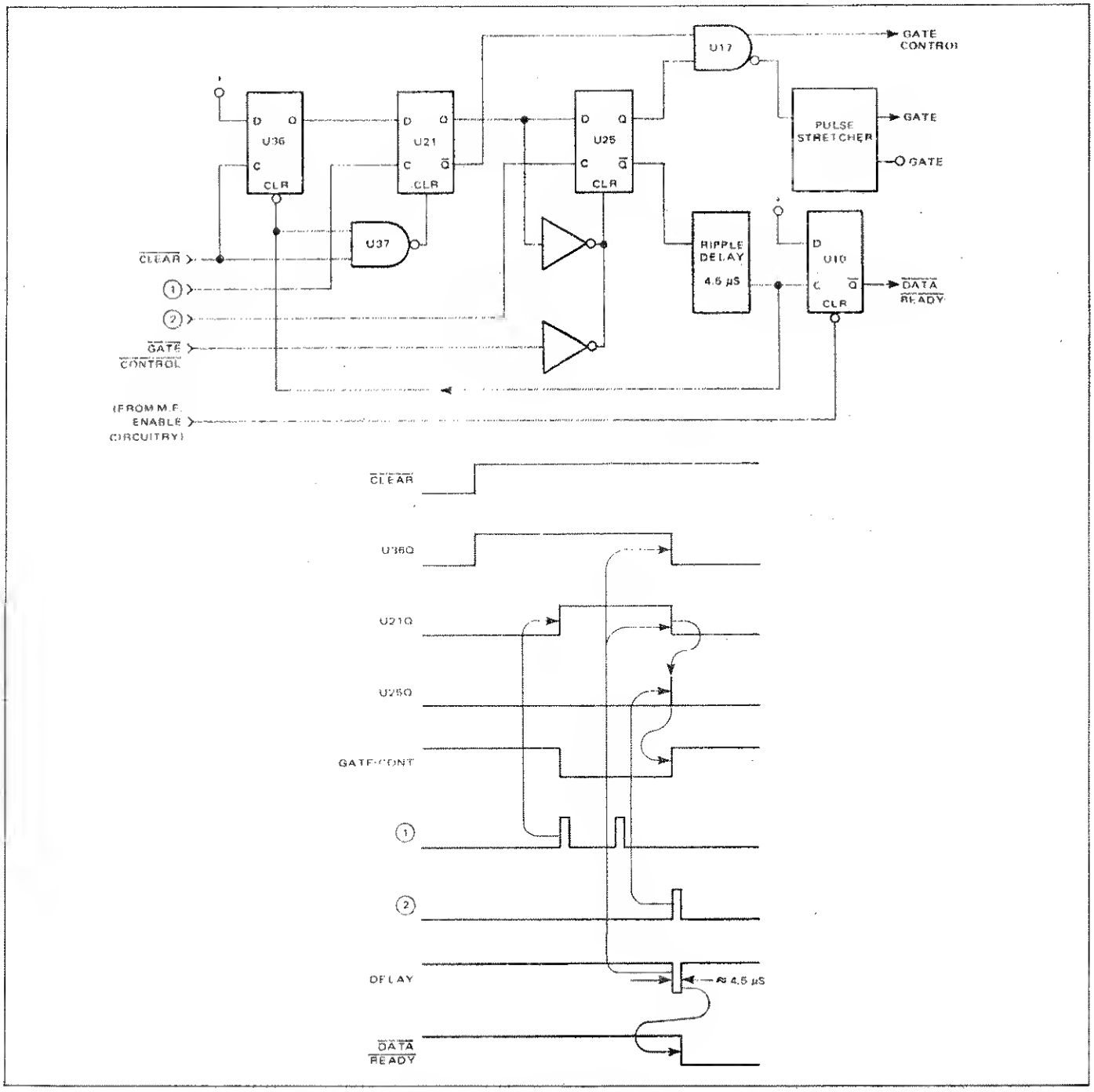


Figure 4.21 - Gate Control

control signal, the DATA READY signal, the gate light control signal, the GATE signal on the rear panel, and, with PARALLEL ENABLE, the UPDATE signal. Referring to figure 4.21, the circuitry is armed when CLEAR goes high setting U36Q true. A positive going edge at input (1) sets U21Q high and U21$\overline{Q}$ low setting the gate control signal false and enabling the GATE circuit. This state continues regardless of what the (1) input level is. A positive going edge at (2) sets U25Q high, setting the gate control signal false and inhibiting the GATE circuit. At the same time U25$\overline{Q}$ goes low generating a 4.5 microsecond negative going ripple delay pulse. The leading edge of the pulse clears U36 and U21 which in turn clears U25. The completion of the gate control also initiates the pulse stretcher. This delay circuit generates a 10 millisecond pulse that sets a minimum limit on the period that the gate line (used to drive the front panel GATE lamp) is on. This circuitry also buffers the output of the gate control line for use on the rear panel (GATE, INT). At the completion of the ripple delay pulse, the DATA READY line goes low informing the microprocessor and the interface that the data in the accumulator counters is complete.

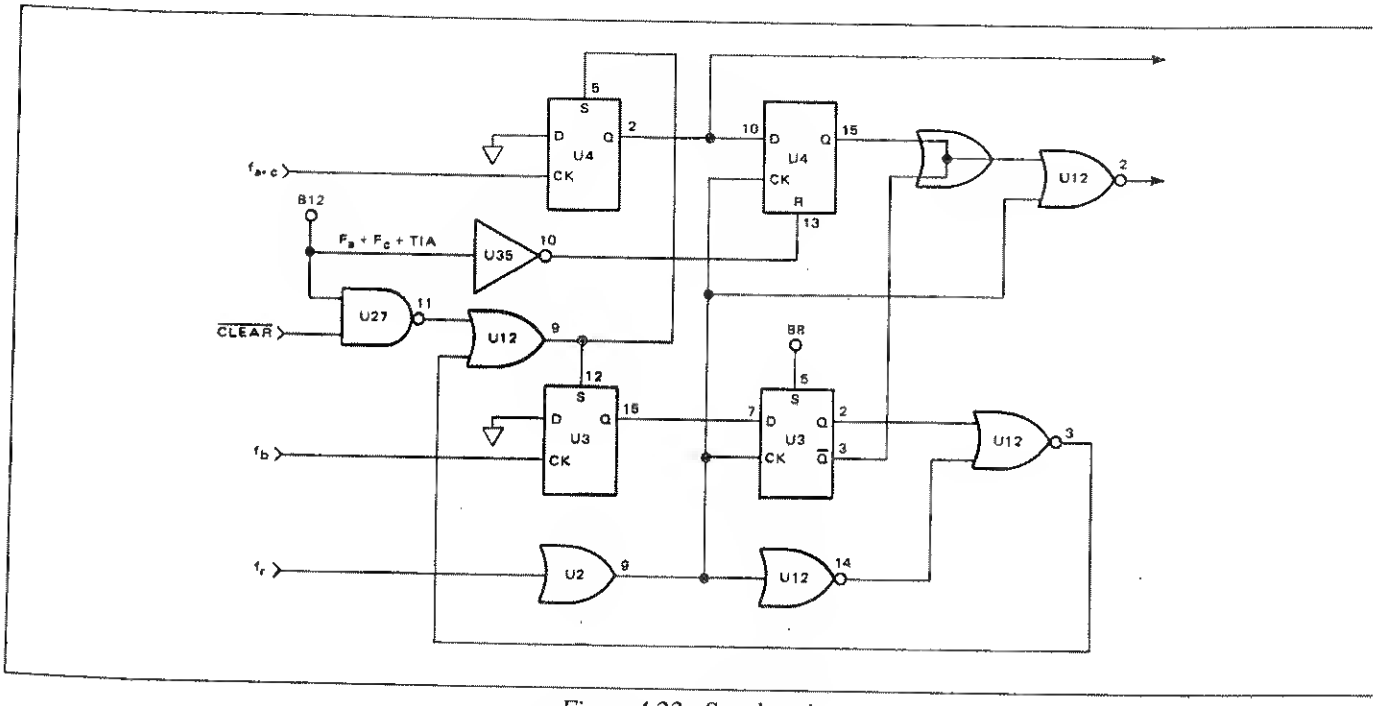
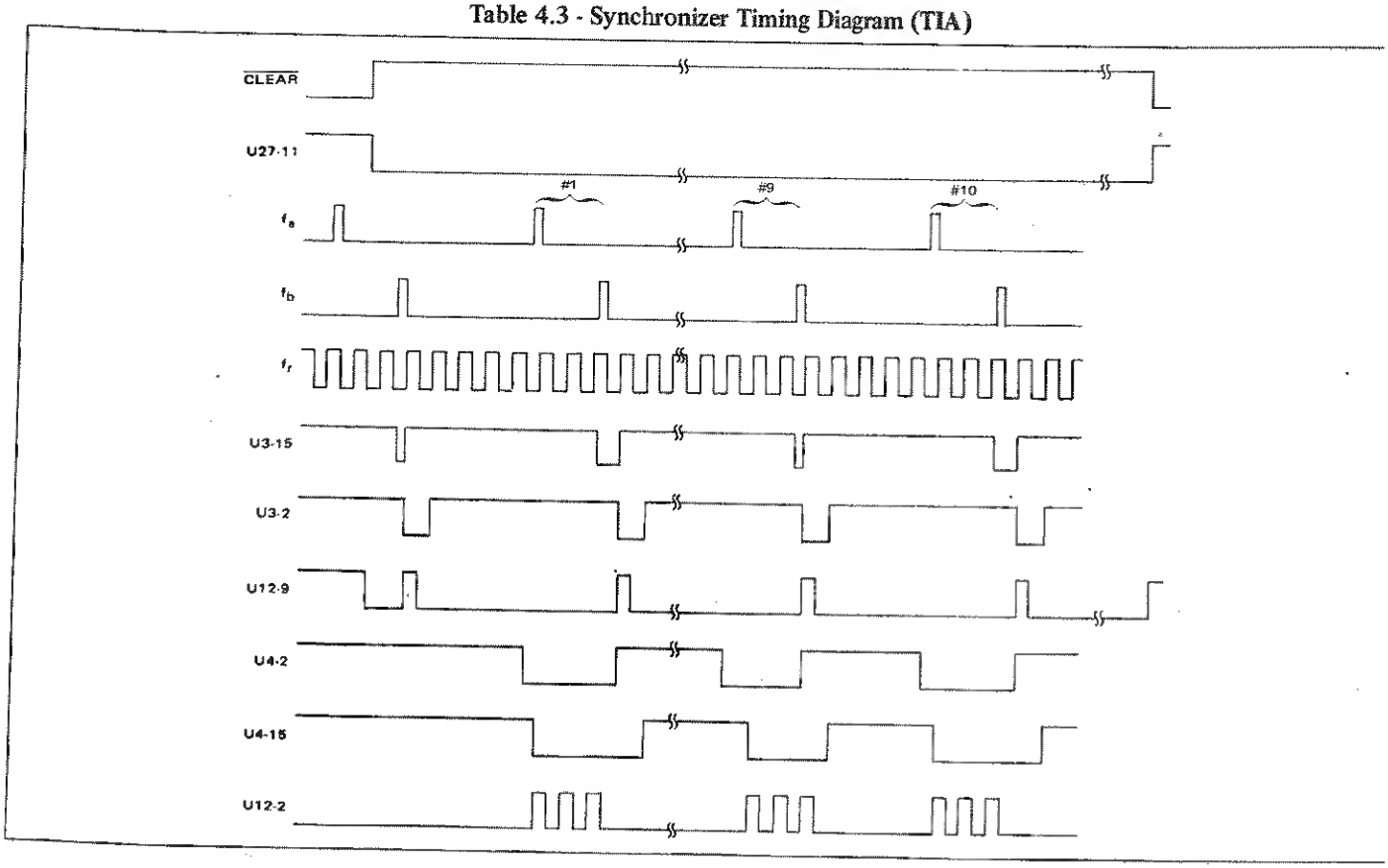


Figure 4.22 - Synchronizer

Table 4.3 - Synchronizer Timing Diagram (TIA)



4.4.9.7 *Synchronizer.* The synchronizer is used to synchronize the gate inputs to the internal clock for Time Interval Average measurements. The circuit, shown in figure 4.22, consists of four ECL D type flip-flops with ECL and T^2L gates.

4.4.9.7.1 The operating sequence starts when CLEAR goes high and an f_b pulse is received, arming the synchronize circuitry. The sequence then proceeds as illustrated in table 4.3 and described in table 4.4.

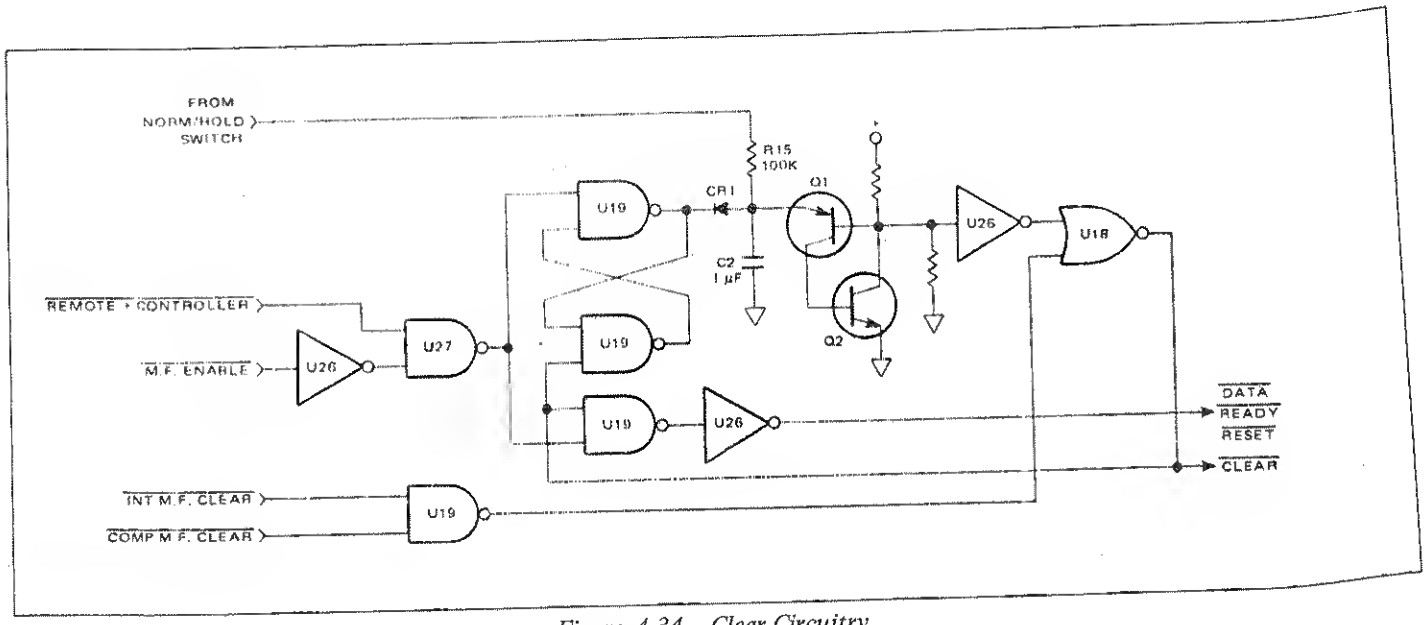


Figure 4.34 - Clear Circuitry

4.4.9.20 Two secondary windings are used; one for the 5.0 and 5.2 volt supplies and the other winding for the +12 and −12 volt supplies. The 5 volt supplies are powered by a positive full wave rectifier, filtered by two 1000 µF capacitors and a 2.2 µF capacitor. The output is routed to four integrated five volt regulators, three wired to provide a fixed +5 volt output and one wired to provide an adjustable 5.2 volt supply. The 5.2 volt supply is used to power the ECL circuits in the instrument.

4.4.9.21 The other winding drives a positive and a negative full wave rectifier. The plus supply powers a fixed +12 volt integrated regulator and the minus supply powers a fixed −12 volt integrated regulator.

4.5 REFERENCE OPTION SUPPLY.

4.5.1 The reference option supply is a single printed circuit board that plugs into the mainframe board at location J10. The supply provides power for the option 22 or 24 reference oscillators and is included when these options are specified. The supply provides a regulated 28 volts to the options as long as the power cable is connected to the line regardless of the position of the front panel power switch.

4.5.2 The supply consists of a 110/220 volt line select switch (the supply precedes the line voltage select card in the power module; this switch must be set separately to the proper line position), transformer, bridge rectifier, 1250 µF filter capacitor and an adjustable 28 volt integrated regulator.

SECTION 5 CALIBRATION

5.1 INTRODUCTION AND DESCRIPTION.

5.1.1 This procedure covers the calibration of the Dana Microprocessing Timer/Counter. The procedure consists of: voltage adjustments of the Digital-to-Analog Converters (DACs), the +5.2 volt power line, and the hysteresis compensation circuitry; sensitivity adjustments of the signal conditioning circuits; frequency response adjustments of the attenuators and; frequency accuracy adjustments of the reference frequency multipliers and reference oscillator.

5.1.2 The location of the reference oscillator adjustment depends on whether the instrument is equipped with the standard or one of the two available options.

5.2 REQUIRED EQUIPMENT.

5.2.1 A list of equipment required to perform the procedure is provided in table 5.1.

5.3 DISASSEMBLY, CALIBRATION.

5.3.1 Access to the calibration points is obtained by removal of the instrument bottom cover. The cover is held in place by the four captive screws located in each corner. After loosening these screws, the cover can be lifted by pressing up on the cover through access holes at the bottom of the rear panel.

5.4 PRELIMINARY OPERATION.

5.4.1 The following steps must be performed before the calibration procedure is started.

a. Check line voltage.

b. Verify that proper voltage and fuse rating have been chosen for the instrument. If the instrument

Table 5.1 - Required Equipment

NOTE

Minimum use specifications are the principal parameters required for performance of the calibration, and are included to assist in the selection of alternate equipment. Satisfactory performance of alternate items shall be verified prior to use. All applicable equipment must bear evidence of current calibration.

Item	Minimum Use Specification	Calibration Equipment
1. Frequency Standard	1 MHz, 5 MHz or 10 MHz	
2. Oscilloscope	100 MHz Bandwidth	TEK 454
3. Voltmeter	4-digit accuracy, 10 MΩ or greater input resistance	Dana 4200
4. Signal Generator	100 Hz – 100 MHz 1V adjustable	HP651B HP8654A
5. Signal Generator	100 MHz – 512 MHz (9035 only)	HP8654A
6. Square Wave Generator	50V P.P. @ 10 kHz	TEK 105
7. Alignment Tool	Blade (non-metallic)	General Cement 9300
8. BNC T-Connector		
9. Sampling Voltmeter	0 – 512 MHz	HP3406
10. Pulse Generator	8 ns pulse width	Datapulse 112 or 110B

is equipped with an optional reference oscillator, check the option power supply line selector.

c. Connect the power cord to the line. Set the power switch (PWR) to ON and provide 1/2 hour for temperature stabilization.

d. Refer to the operating manuals provided with the calibration equipment to be used and provide appropriate warmup time as required.

e. Review the calibration procedure and verify that all necessary equipment and hardware are assembled. Preset controls as given below.

NORM/HOLD	NORM	
SEP/TEST/COM	SEP	
"FUNCTION"	F_A	
TRIGGER STATUS	CH A	CH B
SLOPE	↑	↓
AC/DC	DC	DC
TL	000	000

5.5 CALIBRATION POINTS.

5.5.1 The calibration points are located on the main PC board, signal conditioning modules, and reference. The locations are shown in figure 5.6.

5.6 PROCEDURE.

5.6.1 The calibration procedure is designed to keep the instrument operating within the published specifications for indefinite periods of time. The order of adjustment has been determined to produce the least interaction between adjustments. For best results, the procedure should be followed as presented.

5.6.2 Power Supply (Main Logic Board).

a. Reference voltmeter to GND pin (see figure 5.6).

b. Monitor +5.2 volt line and adjust R61 for a voltmeter reading of +5.2 volts ± .05 volts.

5.6.3 DAC.

a. Program +3V trigger level for channel A. With a voltmeter, monitor CH A T/L output on rear panel.

b. Adjust + full scale potentiometer R3 for a voltmeter reading of +3.000 volts ± .003 volts.

c. Program –3V trigger level for channel A.

d. Adjust – full scale potentiometer R15 for a voltmeter reading of –3.000 volts ± .003 volts.

e. Program +3V trigger level for channel B. With a voltmeter, monitor CH B T/L output on rear panel.

f. Adjust + full scale potentiometer R4 for a voltmeter reading of +3.000 volts ± .003 volts.

g. Program –3V trigger level for channel B.

h. Adjust – full scale potentiometer R16 for a voltmeter reading of –3.000 volts ± .003 volts.

5.6.4 Reference Multiplying Circuit (Reference Board).

a. With an oscilloscope referenced to TP1, monitor TP2 and adjust C23 for an oscilloscope display as shown in figure 5.1.

b. Monitor TP3 and adjust C30 for an oscilloscope display of maximum amplitude at 100 MHz, as shown in figure 5.2.

5.6.5 Signal Conditioning Circuit, Channel A and B.

5.6.5.1 *Sensitivity.*

a. Set TL to 0.00 (1V range) for both channel A and B. Select F_A, + Slope, DC Coupled, Separate Mode, Timebase 10^{-1} Sec.

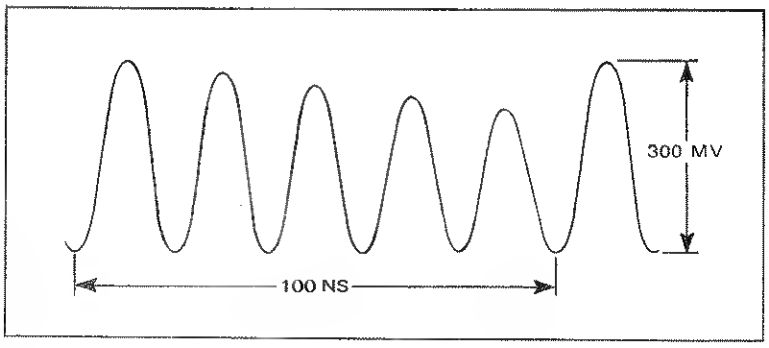


Figure 5.1 - 5th Harmonic Output

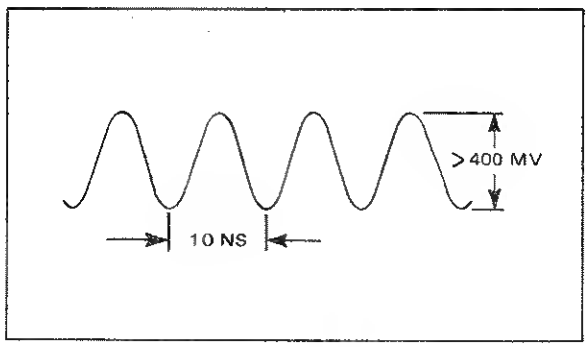


Figure 5.2 - 100 MHz Signal

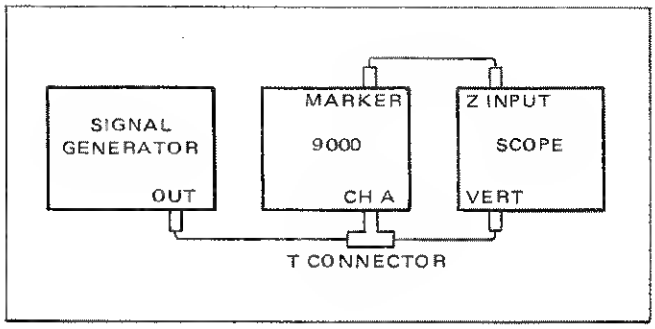


Figure 5.3 - Marker Hookup

b. Apply a 1V RMS, 100 Hz signal to the channel A input connector and verify a reading of 100 Hz.

c. Reduce input voltage until no gating occurs.

d. Toggle the channel A slope switch between + and – and adjust potentiometer R58 on channel A signal conditioner for a display in both + and – slope with the least amount of input signal.

e. Select A/B, multiplier +1, and common mode. Set input to 1V RMS and verify a counter display of 1.0.

f. Reduce input voltage until no gating occurs.

g. Toggle the channel B slope switch between + and – and adjust potentiometer R58 on channel B signal conditioner for a display in both + and – slope with the least amount of input signal.

5.6.5.2 *Hysteresis Compensation.*

a. Select TI, common mode. Channel A: + Slope, DC Coupling, Trigger Level + 0.00V; Channel B: – Slope, DC Couple, Trigger Level – .05V. Set vertical gain of oscilloscope to 20 mV/division and sweep to center of reticle.

b. Apply a 100 Hz @ .3V P.P. signal to the channel A input and the oscilloscope vertical input; connect the marker output on the back of the counter to the oscilloscope Z axis (see figure 5.3).

c. Toggle the channel A slope switch between + and – and adjust potentiometer R48 on the channel A signal conditioner for the same trigger levels at both positions of the slope switch.

d. Adjust R58 on the channel A signal conditioner for a trigger point of zero volts.

e. Set channel A for a trigger level of 0.05V. Set channel B for a trigger level of 0.00.

f. Toggle the channel B slope switch between + and – and adjust potentiometer R48 on the channel B signal conditioner for the same trigger levels at both positions of the slope switch.

g. Adjust R58 on the channel B signal conditioner for a trigger point of zero volts.

h. Select A/B, multiplier +6. Set the trigger level on channel A and channel B for 0.00V.

i. Apply a 100 mV RMS, 100 MHz signal to the channel A input connector and verify a counter display of 1.000000.

5.6.5.3 *Attenuator.*

a. Select channel A 10 volt range and apply a 10 kHz 20V P.P. square wave signal to channel A input.

b. With the oscilloscope, monitor pin 8 of U3 and adjust C6 (both on the channel A signal conditioner) for a waveform flatness within ±40 mV. Refer to waveform shown in figure 5.4.

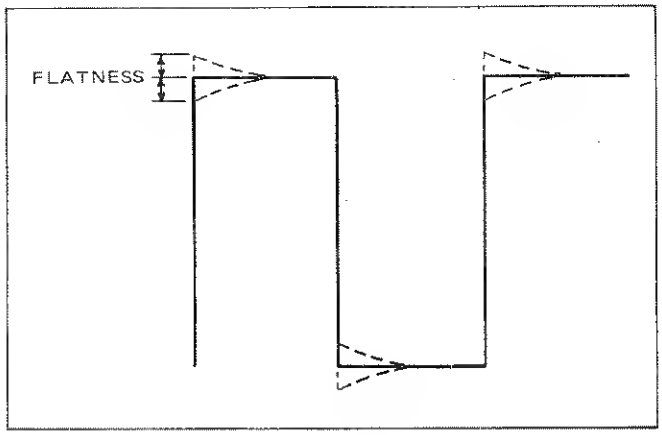


Figure 5.4 - Square Wave Signal

c. Select channel A 100 volt range and increase the amplitude of the 10 kHz to 50V P.P.

d. Adjust C3 on channel A signal conditioner for a waveform flatness to within ±10 mV.

e. Repeat steps b, c, and d for channel B.

Table 5.2 - Internal Reference Oscillators

Oscillator	Aging Rate	Temperature Stability	Stability
Standard	$<3x10^{-7}$/mo.	$<5x10^{-6}$ 0°C to +50°C	$<1x10^{-7}$ with 10% line V variation
Option 22	$<1x10^{-9}$/day	$<5x10^{-9}$ 0°C to +50°C	$<2x10^{-9}$ with 10% line V variation
Option 24	$<1x10^{-10}$/day	$<5x10^{-9}$ 0°C to +50°C	$<2x10^{-9}$ with 10% line V variation

5.6.6 **Prescaler (Model 9035 only).**

a. Set potentiometer R31 to the center of its mechanical span and R19 fully clockwise. Note that the IN-RANGE indicator on the front panel is lit.

b. Adjust R19 counterclockwise until IN-RANGE indicator goes out and continue counterclockwise for ≈ 1/20 of a revolution.

c. Apply a 100 MHz signal at 15 millivolts RMS to the channel C input and verify the IN-RANGE indicator lights. Repeat at 50 MHz intervals to 500 MHz.

d. If counter readings appear noisy (not caused by the frequency source), adjust potentiometer R31 clockwise until noise abates and repeat step c.

5.6.7 **Internal Reference.**

5.6.7.1 There are three internal reference oscillators available for the Series 9000. (See table 5.2.)

5.6.7.2 The calibration adjustment for the standard oscillator is a single variable capacitor adjustment, accessible at the rear panel (OSC ADJ). The options have two adjustments (COARSE and FINE), accessible at the rear panel.

5.6.7.3 *Reference Oscillator Frequency Check.*

a. Select the following control settings:

FUNCTION	F_A
TIMEBASE	10
CHANNEL A SLOPE	↑
COUPLING	DC
TL	0.00
SEP/TEST/COM	COM

b. Connect the 1 MHz frequency standard to the channel A input.

c. The difference between the internal reference oscillator and the 1 MHz frequency standard can be determined by the following equation:

Internal Oscillator Frequency = (20,000,000 - Counter Reading).

d. Some examples of various counter readings and the frequency difference that is indicated are shown below:

Counter Display	Internal Reference Osc.
999.9950 kHz	10,000.050 kHz
999.9975 kHz	10,000.075 kHz
1000.0000 kHz	10,000.000 kHz
1000.0025 kHz	9,999.975 kHz
1000.0050 kHz	9,999.950 kHz

5.6.7.4 *Adjustment Procedure.*

a. Connect the 1 MHz 1V RMS frequency standard to the vertical input of the oscilloscope.

b. Connect the REF OUT signal from the back panel of the counter to the extemal trigger of the oscilloscope.

c. Set scope controls as follows:

TRIGGER	
SLOPE:	+
COUPLING:	AC
SOURCE:	EXT
SWEEP MODE	
NORM TRIGGER	
SWEEP:	.05 μS
CHANNEL INPUT:	AC
volts/div	Depends on amplitude of frequency standard
TRIGGER LEVEL:	center of mechanical span

d. Adjust trigger level for an oscilloscope display of the frequency standard output.

e. If the instrument is equipped with the standard reference oscillator, adjust OSC ADJ for a oscilloscope display that is as stationary as possible (does not drift to the left or right).

f. If the instrument is equipped with option 22 or 24 high stability reference oscillator, remove the two protective metal caps from the COARSE and FINE adjustment access holes in the back panel. Using the two exposed controls, perform the procedure outlined in step e.

g. To determine the drift rate of the calibrated instrument, measure the time it takes the oscilloscope pattern to drift 5 divisions on the oscilloscope. The oscillator drift can be determined from figure 5.5.

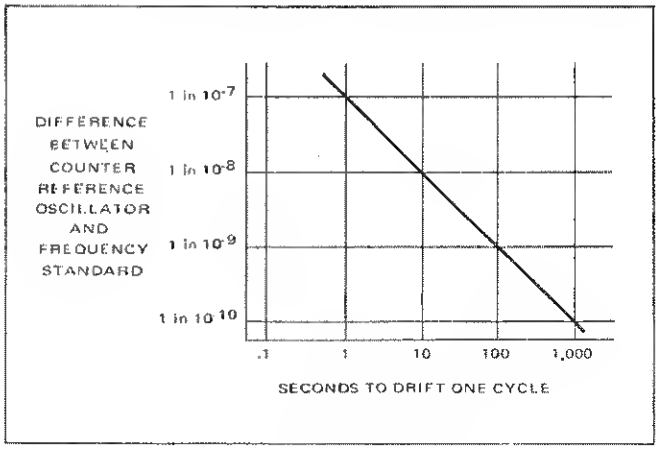


Figure 5.5 - Oscillator Drift

5.6.8 External Reference Circuit Check.

5.6.8.1 Supply a 1 Megahertz reference signal at 1.5 volts RMS to the rear panel EXT REF connector and verify that the EXT REF light on the front panel is lit. Reduce the input level to 1 volt RMS and verify that the front panel EXT REF light is still on.

5.6.8.2 Supply inputs of 5 and 10 MHz at 1V RMS and repeat the same procedure.

5.7 MAINTENANCE DISASSEMBLY.

5.7.1 Always disconnect the power cord from the instrument when disassembling beyond the calibration stage or when boards are to be removed. Power may be restored to the instrument with boards removed for troubleshooting purposes without damage to the instrument. Also remove power before inserting boards.

5.7.1.1 *Tools Required.* Besides a phillips screwdriver the following tools may be required depending on what is to be disassembled.

	Name	Suggested Type
1.	Long nose pliers	—
2.	Soldering iron	35 watt
3.	Solder	Rosin Core
4.	Solder remover	Solda Pult

5.7.2 Replacing Front Panel LEDs.

a. Lay the 9000 on its side. Loosen the four captive corner screws on the bottom cover and remove cover. Repeat the process on the top cover.

b. Disconnect cables to the signal connector boards and prescaler (9035 only).

c. Remove the four button head phillips screws holding the front panel to the bottom frame.

d. Remove the four button head phillips screws holding the front panel to the top frame.

e. Pull keyboard out as far as track will allow.

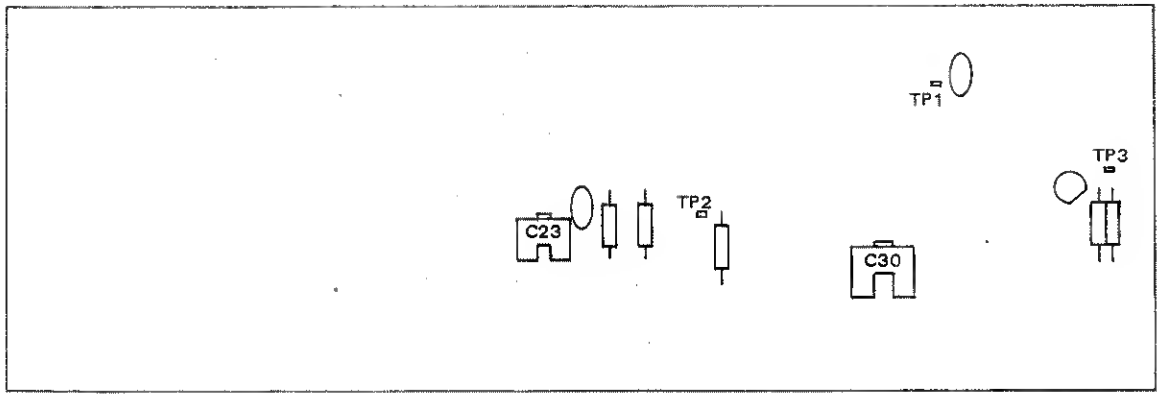
f. Press front panel display board assembly out from case.

g. Remove 5 phillips screws mounting display board to front panel and separate. Seven segment LEDs are socket mounted and can be unplugged. LED lamps are unsoldered for removal.

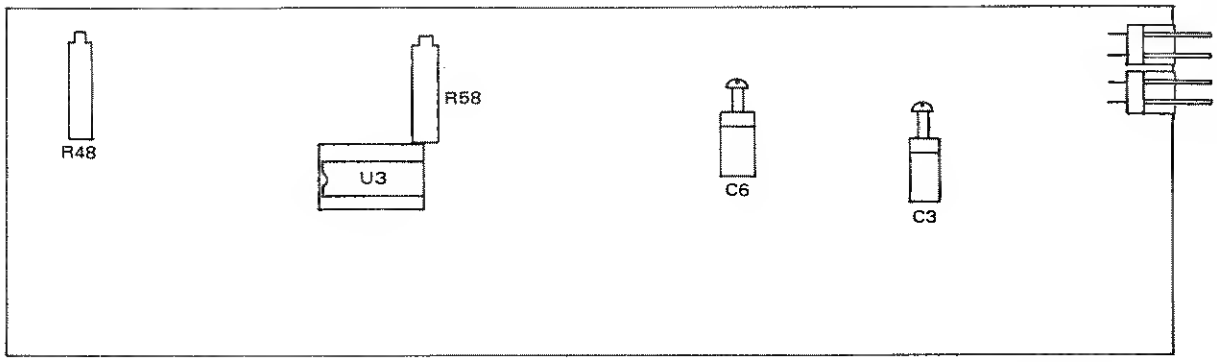
5.8 BOARD REVISION.

5.8.1 Every effort is made to keep the manual concurrent with the instrument despite changes to the design, which are an inevitable adjunct of the manufacturing process. The manual is updated and periodically reprinted throughout the year. In between printings, Addendums and Errata Sheets are added to the manual if required to implement the reprinted copy.

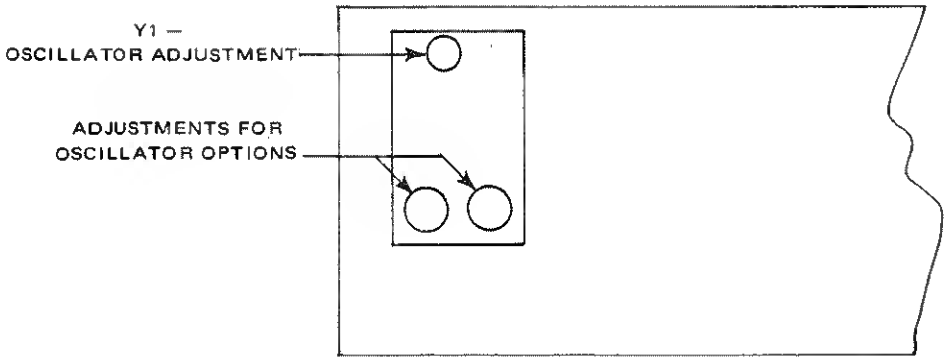
5.8.2 Any design change is accompanied by an updating of a board revision. Such change could be as simple as a revised hole size or as complex as major modifications of the circuitry. The revision of a board is indicated by the letter preceding the assembly number on the board; the revision of the assembly drawing in Section 6 or on an Errata Sheet is indicated by the letter following the assembly number, located below the drawing. Comparing the revision letters can indicate how closely the drawing corresponds to the board.

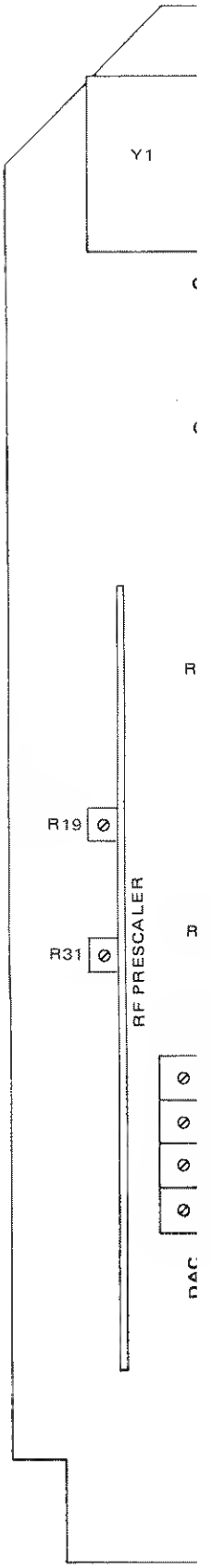


REFERENCE



CHANNEL A OR B





CHANNEL B *

R3
R4
R15
R16

*CHANNEL A
EQUIPPED W

& B I
WITH I

SECTION 6 DRAWINGS

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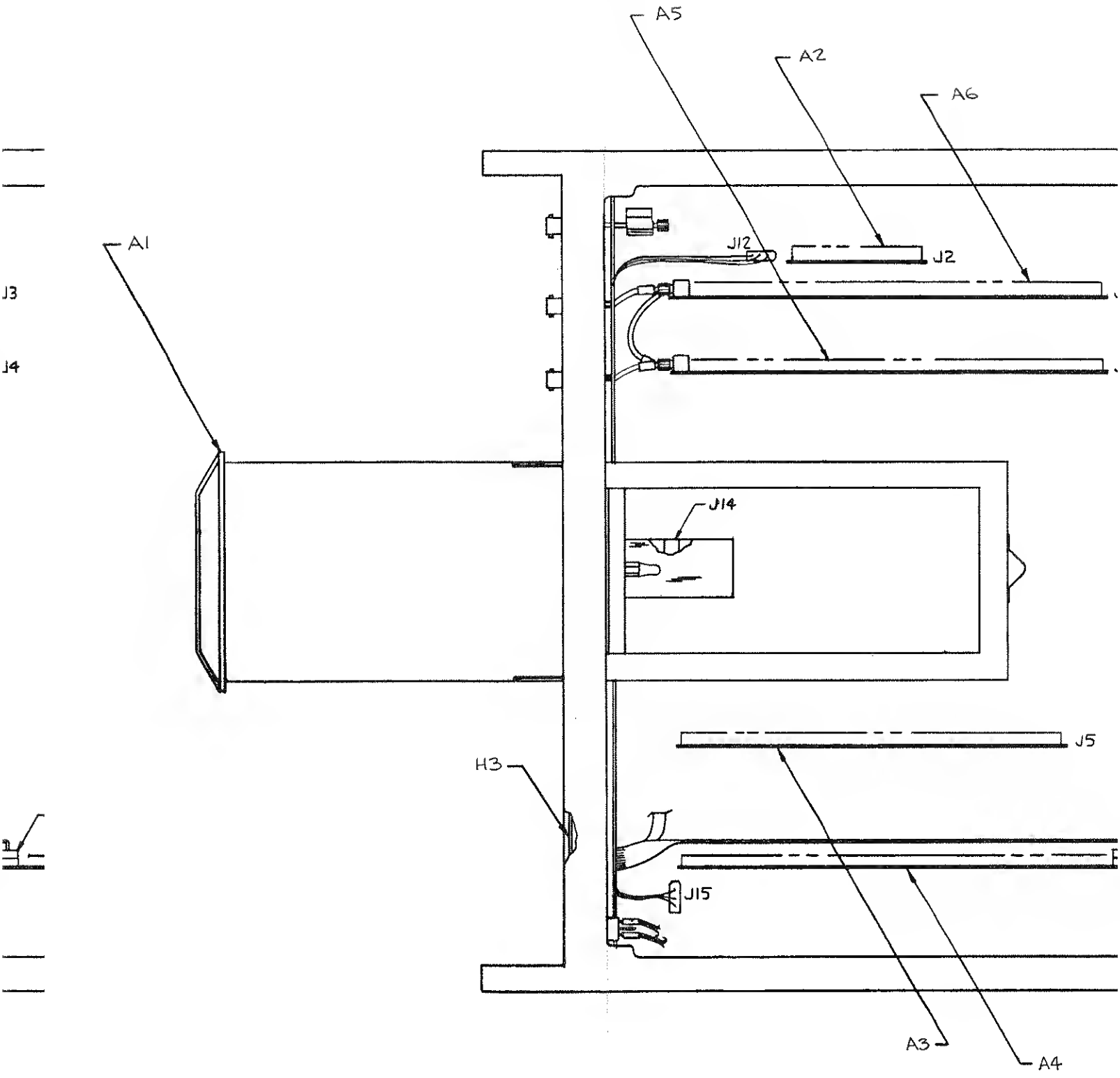
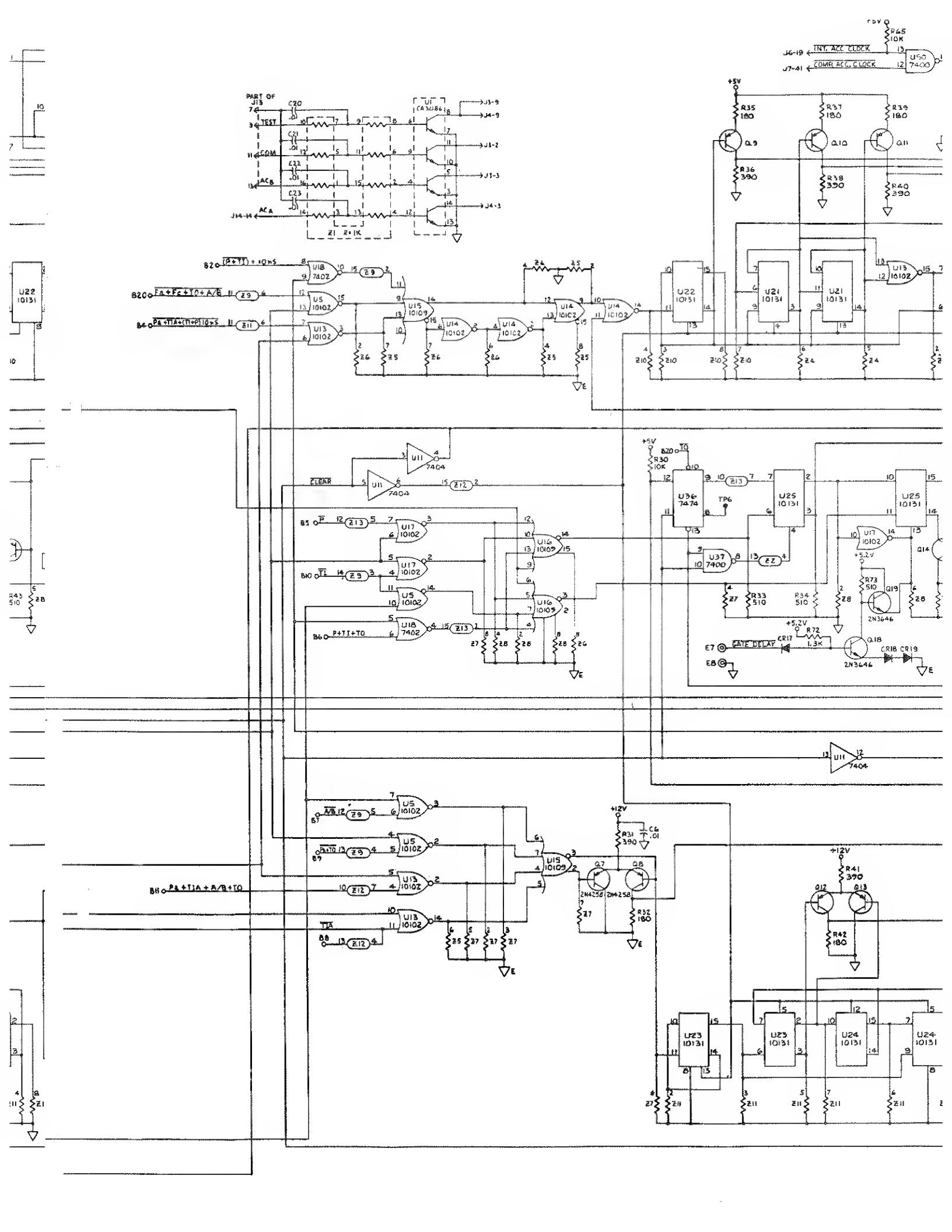
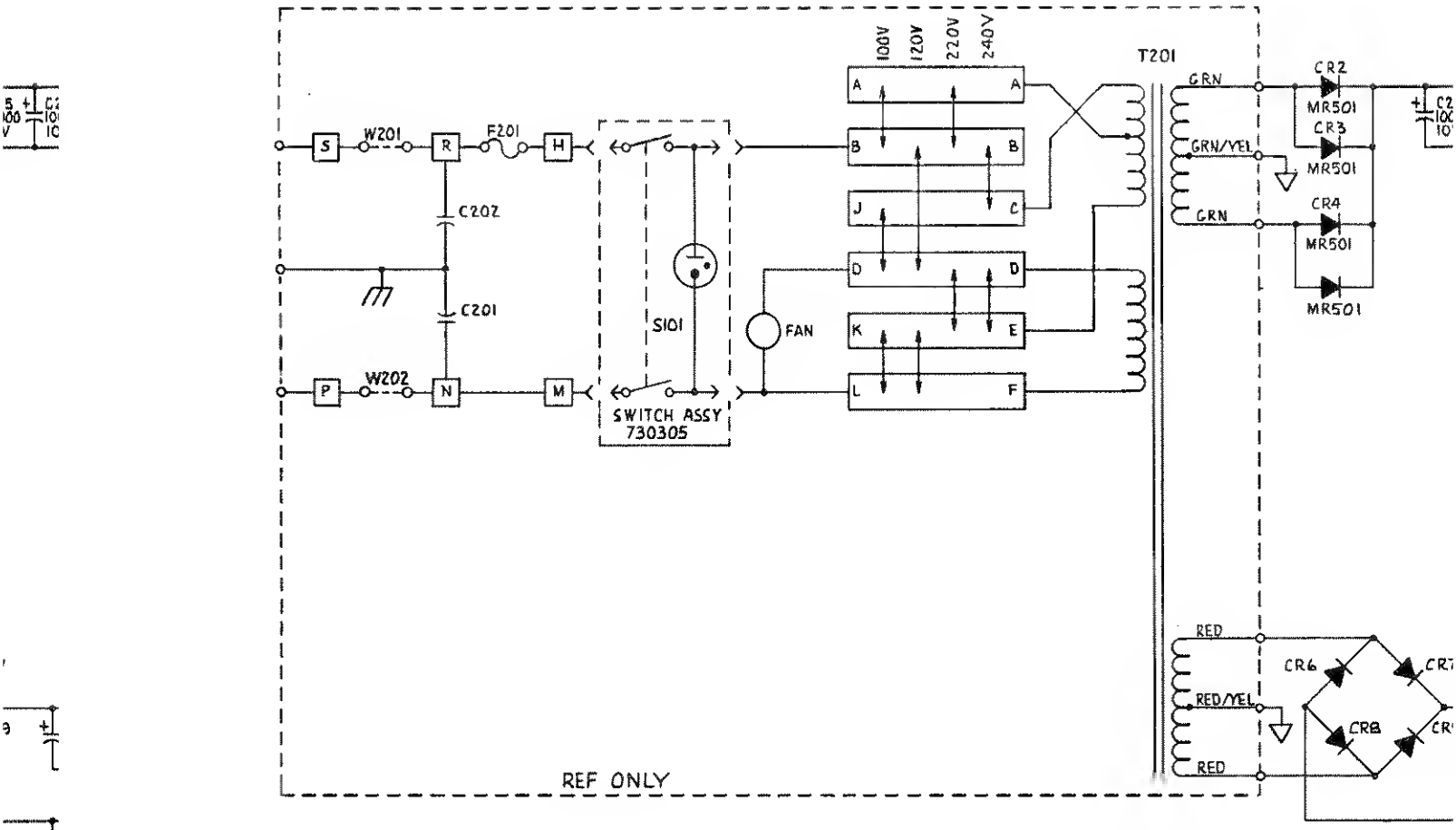
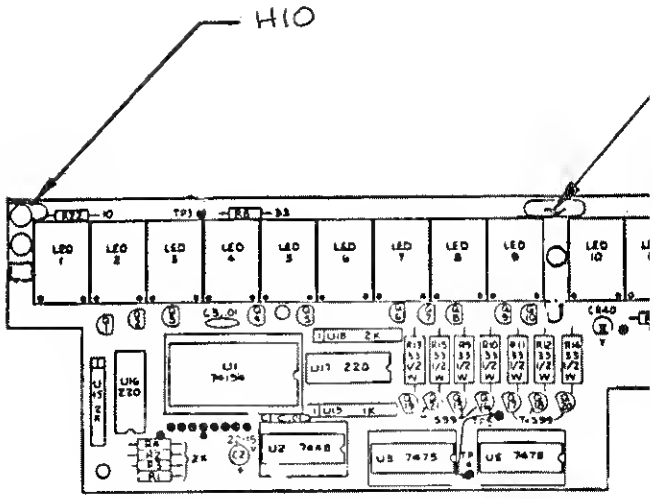


Figure 6.1 - Layout, Counter (406770)

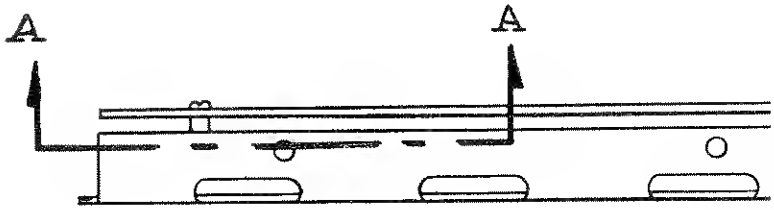

+5V
R65 10K
INT. ACC CLOCK
COMP. ACC. CLOCK
U50 7400
PART OF J13
TEST
COM
ACB
ACA
J14-14
U1 CA3086
J3-9
J4-9
J3-2
J3-3
J4-3
C20
C21
C22
C23
Z1 R+1K
R35 180
R37 180
R39 180
Q9
Q10
Q11
R36 390
R38 390
R40 390
B20 (P+T1)+10nS
B20 Pa+Pc+T0+A/B
B6 Pa+T1A+(T1+P)10nS
U18 7402
U5 10102
U13 10102
U15 10109
U14 10102
U22 10131
U21 10131
U13 10102
Z9
Z11
Z6
Z5
Z10
Z4
Z8
U11 7404
CLEAR
Z12
Z13
B5 P
B10 T1
B6 P+T1+T0
U17 10102
U16 10109
U18 7402
Z7
U36 7474
U25 10131
U37 7400
TP6
Q13
Q14
Z2
R30 10K
B20 T0
+5.2V
R73 510
Q19
2N3646
R33 510
R34 510
E7 GATE DELAY
CR17
R72 1.3K
Q18
CR18 CR19
E8
B7 A/B
B9 A+T0
B11 Pa+T1A+A/B+T0
T1A
B8
R31 390
C6 .01
+12V
Q7
Q8
2N4258
R32 180
R41 390
Q12
Q13
R42 180
U23 10131
U24 10131
Z11

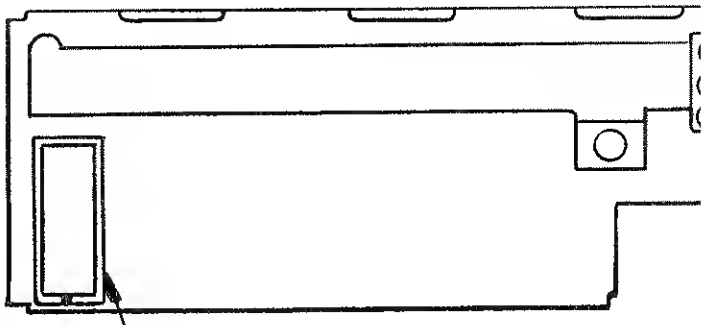

100V
120V
220V
240V
T201
S
W201
R
F201
H
C202
C201
P
W202
N
M
S101
SWITCH ASSY
730305
FAN
A
B
J
C
D
K
E
L
F
GRN
GRN/YEL
GRN
CR2
MR501
CR3
MR501
CR4
MR501
MR501
RED
RED/YEL
RED
CR6
CR8
REF ONLY

721763-A

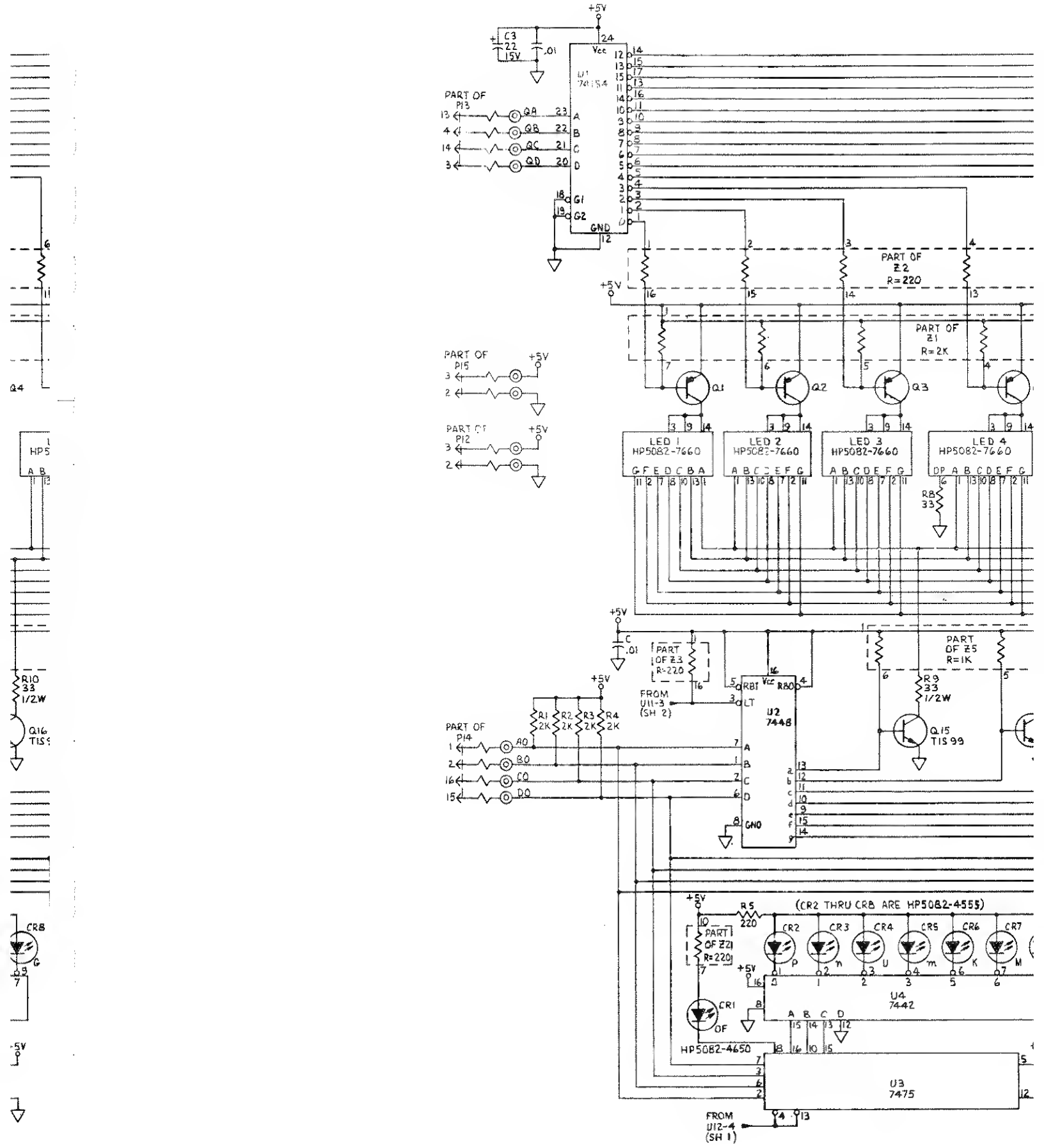


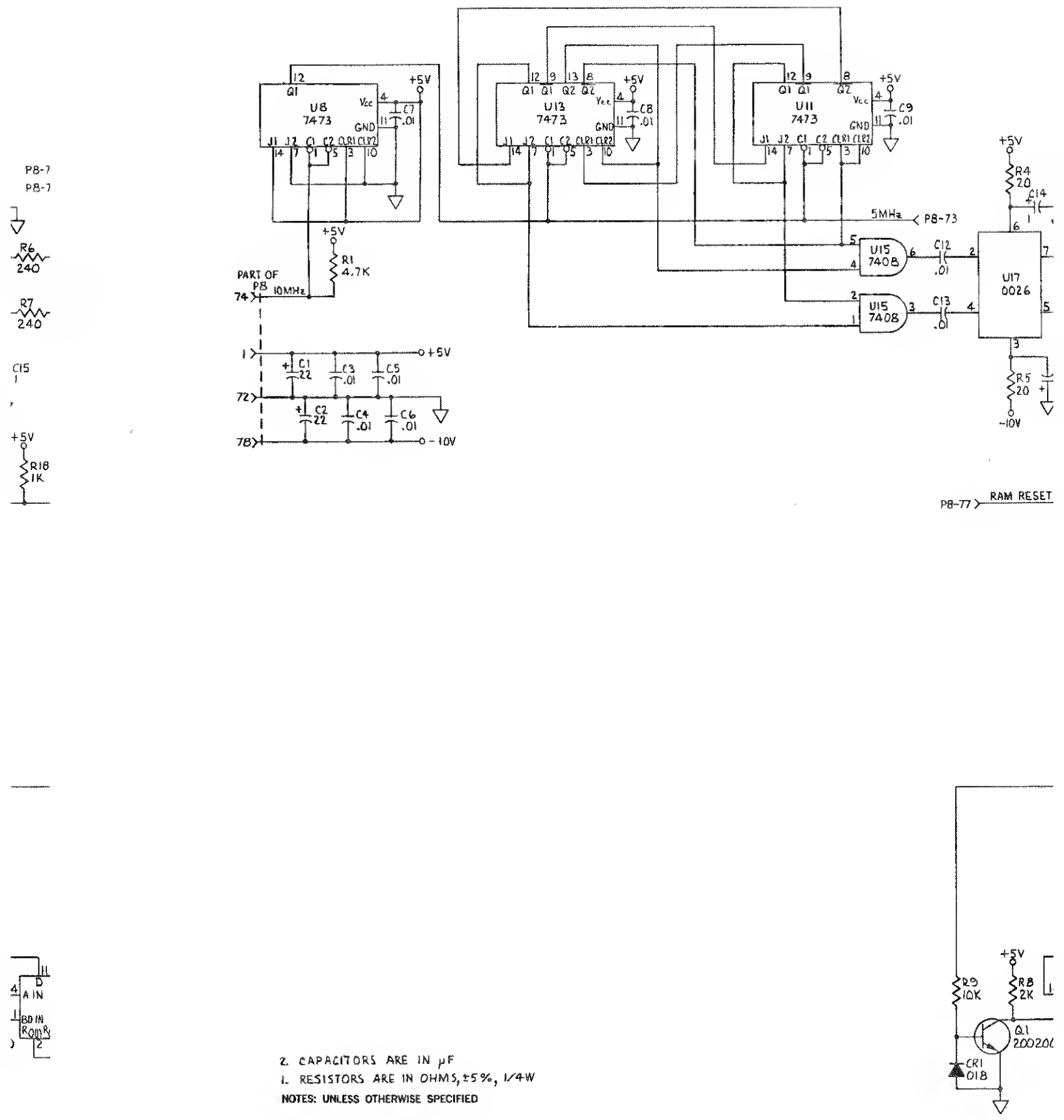
VIEW A-A





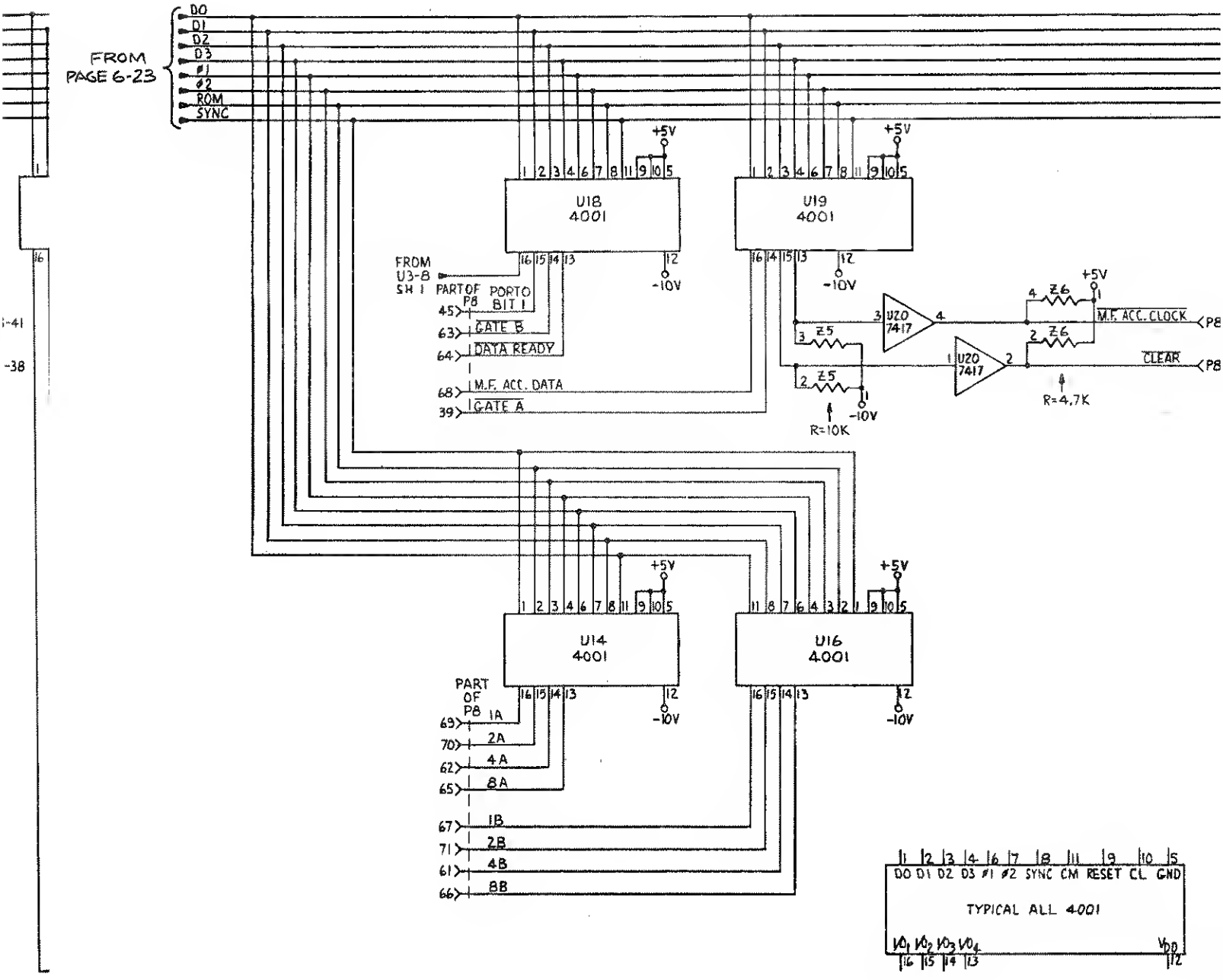
406771-B

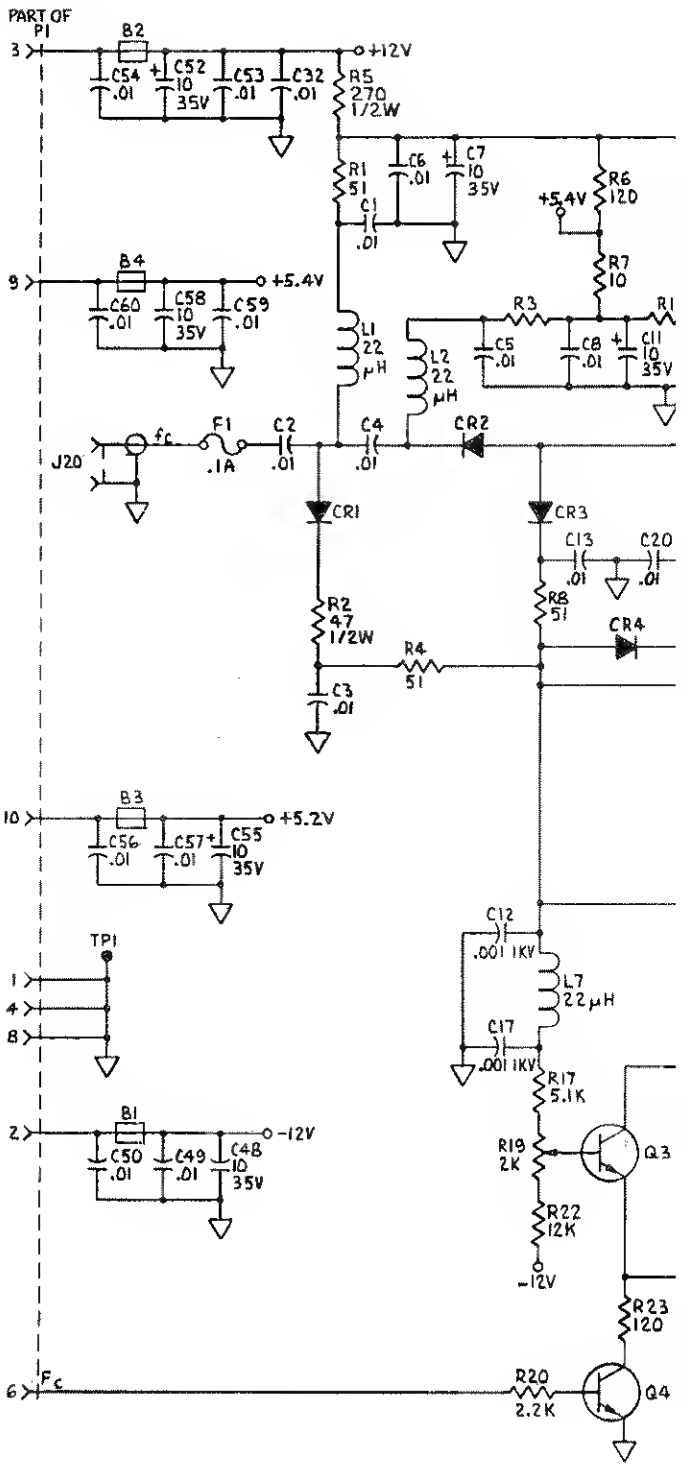

+5V
C3
22
15V
.01
Vcc
U1
7415.4
PART OF
P13
QA
QB
QC
QD
A
B
C
D
G1
G2
GND
PART OF
Z2
R=220
PART OF
Z1
R=2K
PART OF
P15
PART OF
P12
Q1
Q2
Q3
LED 1
HP5082-7660
LED 2
HP5082-7660
LED 3
HP5082-7660
LED 4
HP5082-7660
R8
33
C
.01
PART
OF Z3
R=220
FROM
U11-3
(SH 2)
PART
OF Z5
R=1K
R9
33
1/2W
Q15
TIS 99
U2
7448
RBI
RBO
LT
GND
PART OF
P14
R1
2K
R2
2K
R3
2K
R4
2K
A0
B0
C0
D0
R5
220
(CR2 THRU CR8 ARE HP5082-4555)
CR2
CR3
CR4
CR5
CR6
CR7
PART
OF Z1
R=220
CR1
OF
HP5082-4650
U4
7442
U3
7475
FROM
U12-4
(SH 1)



2. CAPACITORS ARE IN μF
1. RESISTORS ARE IN OHMS, ±5%, 1/4W

NOTES: UNLESS OTHERWISE SPECIFIED


FROM PAGE 6-23
D0
D1
D2
D3
Ø1
Ø2
ROM SYNC
U18 4001
U19 4001
U14 4001
U16 4001
+5V
-10V
FROM U3-8 SH 1
PART OF PORT 0 P8 BIT 1
GATE B
DATA READY
M.F. ACC. DATA
GATE A
U20 7417
M.F. ACC. CLOCK
CLEAR
P8
Z5
Z6
R=10K
R=4.7K
PART OF P8
1A
2A
4A
8A
1B
2B
4B
8B
TYPICAL ALL 4001
D0 D1 D2 D3 Ø1 Ø2 SYNC CM RESET CL GND
VDD



4 TRANSISTORS ARE 2002O0
3. DIODES ARE HP 5082-3080
2. CAPACITORS ARE IN μF, 100V
1. RESISTORS ARE IN OHMS, ±5%, 1/4W
NOTES: UNLESS OTHERWISE SPECIFIED

SECTION 7 PARTS LIST

7.1 This section contains lists of replaceable parts arranged in the order of the following subassemblies:

	Page
Counter	7-3
Chassis	7-4
Main Logic	7-5
Front Panel	7-12
Display	7-13
Rear Panel	7-18
Keyboard Module	7-20
Keyboard PCB	7-21
DAC	7-23
Reference	7-25
Computer III	7-28
Signal Conditioner "A"	7-32
Signal Conditioner "B"	7-36
512 MHz Prescaler	7-40

7.2 Manufacturers are identified by FSC numbers listed in table 7.2, "List of Suppliers". The code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1, H4-2, and their supplements.

7.3 Certain parts having 21793 (Dana) listed in the "FSC" column are specially-selected semiconductors. For some of these, standard commercial parts will serve as satisfactory replacements. These Dana parts are identified in table 7.1 along with the commercial equivalent.

Table 7.1

Semiconductor Type:		Equivalent:
007	Diode	Fairchild FD300
009	Transistor	Motorola 2N2905
014	Transistor	Motorola 2N3501
018	Diode	Texas Instruments 1N4448

Table 7.2 - List of Suppliers

FSC	NAME	FSC	NAME
00779	AMP, INC. HARRISBURG, PENNSYLVANIA	05397	UNION CARBIDE CORP. (Materials Systems Division) CLEVELAND, OHIO
01121	ALLEN BRADLEY CO. MILWAUKEE, WISCONSIN	06540	AMATOM ELECTRONIC HARDWARE CO. NEW ROCHELLE, NEW YORK
01295	TEXAS INSTRUMENTS, INC. (Components Group) DALLAS, TEXAS	07263	FAIRCHILD SEMICONDUCTOR (Division of Fairchild Camera & Instrument Corp.) MOUNTAIN VIEW, CALIFORNIA
02660	AMPHENOL CORP. BROADVIEW, ILLINOIS	11237	CTS KEENE, INC. PASO ROBLES, CALIFORNIA
04713	MOTOROLA, INC. (Semiconductor Products Division) PHOENIX, ARIZONA	15636	ELEC-TROL, INC. SAUGUS, CALIFORNIA

Table 7.2 - List of Suppliers continued

FSC	NAME
17856	SILICONIX, INC. SANTA CLARA, CALIFORNIA
21793	DANA LABORATORIES, INC. IRVINE, CALIFORNIA
24226	GOWANDA ELECTRONICS CORP. GOWANDA, NEW YORK
27014	NATIONAL SEMI-CONDUCTOR CORP. SANTA CLARA, CALIFORNIA
27264	MOLEX PRODUCTS CO. DOWNERS GROVE, ILLINOIS
28218	3-M BUSINESS PROD. SALES, INC. ST. PAUL, MINNESOTA
28520	HEYCO (Division of Heyman Mfg. Co.) KENILWORTH, NEW JERSEY
29090	MECHANICAL ENTERPRISES ALEXANDRIA, VIRGINIA
32284	ROTRON CONTROLS (Division of Rotron, Inc.) WOODSTOCK, NEW YORK
32767	GRIFFITH PLASTIC PRODUCT CO. (Nobex Division) BURLINGAME, CALIFORNIA
34553	AMPEREX/MEPCO-ELECTRA HAUPPAUGE, NEW YORK
34649	INTEL SANTA CLARA, CALIFORNIA
50088	MOSTEK CORP. CARROLLTON, TEXAS
50434	HEWLETT-PACKARD CO. (HP Associates) PALO ALTO, CALIFORNIA
56289	SPRAGUE ELECTRIC CO. (Pacific Division) LOS ANGELES, CALIFORNIA
71400	BUSSMAN MFG. (Division of McGraw & Edison Co.) ST. LOUIS, MISSOURI
71471	AEROVOX CORP. (Cinema Plant) MONCKS CORNER, SOUTH CAROLINA
71590	CENTRALAB ELECTRONICS (Division of Globe-Union, Inc.) MILWAUKEE, WISCONSIN
71785	TRW ELECTRONIC COMPONENTS (Cinch Division) ELK GROVE VILLAGE, ILLINOIS
72982	ERIE TECHNOLOGICAL PRODUCTS, INC. ERIE, PENNSYLVANIA
73138	BECKMAN INSTRUMENTS, INC. (Helipot Division) FULLERTON, CALIFORNIA
73445	AMPEREX ELECTRONIC CORP. HICKSVILLE, LONG ISLAND, NEW YORK
74970	E. F. JOHNSON CO. WASECA, MINNESOTA
76493	J. W. MILLER CO. COMPTON, CALIFORNIA
79727	C-W INDUSTRIES WARMINSTER, PENNSYLVANIA
80131	ELECTRONICS INDUSTRIES ASSOC. WASHINGTON, D.C.
81349	MILITARY SPECIFICATIONS
86884	RADIO CORP. OF AMERICA (Electronics Components Division) HARRISON, NEW JERSEY
87730	UNITED MINERAL & CHEMICAL CORP. NEW YORK CITY, NEW YORK
91637	DALE ELECTRONICS, INC. COLUMBUS, NEBRASKA
98159	RUBBER TECK, INC. GARDENA, CALIFORNIA
98291	SEALECTRO CORP. MAMARONECK, NEW YORK
98978	INTERNATIONAL ELECTRONICS RESEARCH CORP. BURBANK, CALIFORNIA
99800	AMERICAN PRECISION INDUSTRIES, INC. (Delevan Division) EAST AURORA, NEW YORK

406770 — Assy., COUNTER

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
A1	406773	ASSY CASE KEYBOARD	21793	406773
A2	406767	ASSY DAC	21793	406767
A3	406768	ASSY REFERENCE	21793	406768
A4	406769	ASSY COMPUTER III	21793	406769
A5	406765	ASSY SIGNAL CONDITIONER A	21793	406765
A6	406766	ASSY SIGNAL CONDITIONER B	21793	406766
A7	406792	ASSY CHASSIS	21793	406792
A8	403530	ASSY POWER CABLE	21793	403530
H1	453541	BUMPER (4*)	21793	453541
H2	615059	SCREW, PPH, 6-32 x 3/16 LG (1*)		
H3	730680	FRONT PANEL OVERLAY (1*)	21793	730680
H4	730686	HIGH VOLTAGE SHIELD (1*)	21793	730686

*Quantity Required

406792 – Assy., CHASSIS

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
A1	406763	MAIN LOGIC PCB ASSY	21793	406763
A2	406771	FRONT PANEL ASSY	21793	406771
A3	406772	REAR PANEL ASSY	21793	406772
H1	610777	CABLE TIE (2*)		T18R
H2	610791	STANDOFF, 6-32 (2*)	06540	8233-B-440-4
H3	615056	SCREW, PPH, 6-32 x 3/16 LG (6*)		
H4	615058	SCREW, PPH, 6-32 x 5/16 LG (6*)		
H5	615059	SCREW, PPH, 6-32 x 3/8 LG (16*)		
H6	617017	NUT, #6 HEX (2*)		
H7	730660	FRONT SUPPORT (1*)	21793	730660
H8	730677	FRAME, DRAWER (1*)	21793	730677

*Quantity Required

406763 – Assy., PCB, MAIN LOGIC

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
A1	406777	CABLE ASSY (REF: Main Logic to Keyboard)					21793	406777
C1	110141	CAP	TANTA	22 MFD	15 V	20%	05397	T368B226M015AS
C2	110143	CAP	TANTA	1 MFD	35 V		05397	T368A105M035AS
C3	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C4	110125	CAP	TANTA	2.2 MFD	35 V		05397	T368B225M035AS
C5	110125	CAP	TANTA	2.2 MFD	35 V		05397	T368B225M035AS
C6	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C7	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C8	110141	CAP	TANTA	22 MFD	15 V	20%	05397	T368B226M015AS
C9	100117	CAP	CERAM	470 PFD	1000 V	10%	71590	DD471
C10	100038	CAP	CERAM	560 PFD	500 V	10%	71590	DD561
C11	100038	CAP	CERAM	560 PFD	500 V	10%	71590	DD561
C12	100038	CAP	CERAM	560 PFD	500 V	10%	71590	DD561
C13	100038	CAP	CERAM	560 PFD	500 V	10%	71590	DD561
C14	100038	CAP	CERAM	560 PFD	500 V	10%	71590	DD561
C15	100038	CAP	CERAM	560 PFD	500 V	10%	71590	DD561
C16	100038	CAP	CERAM	560 PFD	500 V	10%	71590	DD561
C17	100038	CAP	CERAM	560 PFD	500 V	10%	71590	DD561
C18	100038	CAP	CERAM	560 PFD	500 V	10%	71590	DD561
C19	100038	CAP	CERAM	560 PFD	500 V	10%	71590	DD561
C20	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C21	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C22	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C23	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C24	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C25	110174	CAP	ELECT	10,000 MFD	10 V			39CS10HP14
C26	110174	CAP	ELECT	10,000 MFD	10 V			39CS10HP14
C27	110157	CAP	ELECT	470 MFD	25 V		34553	ET471X025A01
C28	110067	CAP	ELECT	2000 MFD	35 V		87730	2000DXW35
C29	110143	CAP	TANTA	1 MFD	35 V		05397	T368A105M035AS
C30	100057	CAP	CERAM	.1 MFD	500 V	20%	56289	5GA-P10
C31	110143	CAP	TANTA	1 MFD	35 V		05397	T368A105M035AS
C32	110125	CAP	TANTA	2.2 MFD	35 V		05397	T368B225M035AS
C33	110143	CAP	TANTA	1 MFD	35 V		05397	T368A105M035AS
C34	110125	CAP	TANTA	2.2 MFD	35 V		05397	T368B225M035AS
C35	110143	CAP	TANTA	1 MFD	35 V		05397	T368A105M035AS
C36	100057	CAP	CERAM	1 MFD	500 V	20%	56289	5GA-P10
C37	110125	CAP	TANTA	2.2 MFD	35 V		05397	T368B225M035AS
C38	110143	CAP	TANTA	1 MFD	35 V		05397	T368A105M035AS
C39	110125	CAP	TANTA	2.2 MFD	35 V		05397	T368B225M035AS
C40	110141	CAP	TANTA	22 MFD	15 V	20%	05397	T368B226M015AS

406763 – Assy., PCB, MAIN LOGIC *continued*

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
C41	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C42	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C43	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C44	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C45	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C46	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C47	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C48	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C49	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C50	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C51	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C52	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C53	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C54	110141	CAP	TANTA	22 MFD	15 V	20%	05397	T368B226M015AS
C55	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C56	110151	CAP	TANTA	10 MFD	35 V	20%	05397	T362C106M035A
C57	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C58	110151	CAP	TANTA	10 MFD	35 V	20%	05397	T362C106M035A
C59	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C60	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C61	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C62	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C63	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C64	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C65	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C66	110141	CAP	TANTA	22 MFD	15 V	20%	05397	T368B226M015AS
C67	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C68	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
CR1	211083	DIODE	SILICO		018		21793	211083
CR2	210070	DIODE					04713	MR501
CR3	210070	DIODE					04713	MR501
CR4	210070	DIODE					04713	MR501
CR5	210070	DIODE					04713	MR501
CR6	210004	DIODE	SILICO				81349	1N4004
CR7	210004	DIODE	SILICO				81349	1N4004
CR8	210004	DIODE	SILICO				81349	1N4004
CR9	210004	DIODE	SILICO				81349	1N4004
CR10	210004	DIODE	SILICO				81349	1N4004
CR11	210004	DIODE	SILICO				81349	1N4004
CR12	210004	DIODE	SILICO				81349	1N4004
CR13	210004	DIODE	SILICO				81349	1N4004

406763 – Assy., PCB, MAIN LOGIC *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
CR14	210004	DIODE SILICO	81349	1N4004
CR15	210004	DIODE SILICO	81349	1N4004
CR16	210070	DIODE	04713	MR501
CR17	211083	DIODE SILICO 018	21793	211083
CR18	211083	DIODE SILICO 018	21793	211083
CR19	211083	DIODE SILICO 018	21793	211083
H1	453900	POST, SWAGE (35*)	21793	453900
H2	600664	PIN, FEMALE (3*)	27264	M93-102
H3	600665	PIN, MALE (6*)	27264	R62-3
H4	600786	TEST POINT (291*)	00779	1-87022-0
H5	600803	HEATSINK, T03 (2*)	98978	HP3-T03-8B
H6	610112	PRESSNUT, 4-40 (6*)		
H7	610487	MOUSETAIL, (REF: C25–C28, Y1) (8*)	98159	2829-75-3
H8	610533	PRESSNUT, 6-32 (12*)		
H9	920419	SOCKET, IC, 16 PIN (REF: J13, U2-U8, U12-U17, U21-U25, U28, U31, U38-U42, U46-U49) (30*)		CA-16S-TSD-E
H10	920460	SOCKET, IC, 14 PIN (REF: U1, U9-U10, U18-U20, U26, U27, U29, U30, U32-U37, U43-U45, U50) (21*)		CA-14S-TSD-E
H11	500044	TUBING, .20 ± .04 LG (4*)		
H12	615045	SCREW, PPH, 4-40 x 7/16 LG (12*)		
H13	617016	NUT, HEX #4 (4*)		
H14	617077	LOCKWASHER #4 (4*)		
L1	310068	INDUCTOR 1 μH 10%	99800	1537-12
Q1	200088	TRANS SILICO PNP	80131	2N4248
Q2	200037	TRANS SILICO NPN	80131	2N3646
Q3	200088	TRANS SILICO PNP	80131	2N4248
Q4	200088	TRANS SILICO PNP	80131	2N4248
Q5	200088	TRANS SILICO PNP	80131	2N4248
Q6	200088	TRANS SILICO PNP	80131	2N4248
Q7	200099	TRANS	81349	2N4258
Q8	200099	TRANS	81349	2N4258
Q9	200088	TRANS SILICO PNP	80131	2N4248
Q10	200088	TRANS SILICO PNP	80131	2N4248
Q11	200088	TRANS SILICO PNP	80131	2N4248
Q12	200088	TRANS SILICO PNP	80131	2N4248
Q13	200088	TRANS SILICO PNP	80131	2N4248
Q14	200088	TRANS SILICO PNP	80131	2N4248
Q15	200088	TRANS SILICO PNP	80131	2N4248

*Quantity Required

406763 – Assy., PCB, MAIN LOGIC *continued*

REF DES	DANA P/N	DESCRIPTION				FSC	MANU P/N
Q16	200088	TRANS	SILICO	PNP		80131	2N4248
Q17	200088	TRANS	SILICO	PNP		80131	2N4248
R1	000103	RES	CARBON	10 K	5% 1/4W	81349	RC07GF103J
R2	000103	RES	CARBON	10 K	5% 1/4W	81349	RC07GF103J
R3	000103	RES	CARBON	10 K	5% 1/4W	81349	RC07GF103J
R4	000821	RES	CARBON	820 OHM	5% 1/4W	81349	RC07GF821J
R5	000511	RES	CARBON	510 OHM	5% 1/4W	81349	RC07GF511J
R6	000511	RES	CARBON	510 OHM	5% 1/4W	81349	RC07GF511J
R7	000221	RES	CARBON	220 OHM	5% 1/4W	81349	RC07GF221J
R8	000511	RES	CARBON	510 OHM	5% 1/4W	81349	RC07GF511J
R9	000221	RES	CARBON	220 OHM	5% 1/4W	81349	RC07GF221J
R10	000821	RES	CARBON	820 OHM	5% 1/4W	81349	RC07GF821J
R11	000511	RES	CARBON	510 OHM	5% 1/4W	81349	RC07GF511J
R12	000471	RES	CARBON	470 OHM	5% 1/4W	81349	RC07GF471J
R13	000103	RES	CARBON	10 K	5% 1/4W	81349	RC07GF103J
R14	000103	RES	CARBON	10 K	5% 1/4W	81349	RC07GF103J
R15	000104	RES	CARBON	100 K	5% 1/4W	81349	RC07GF104J
R16	000302	RES	CARBON	3 K	5% 1/4W	81349	RC07GF302J
R17	000302	RES	CARBON	3 K	5% 1/4W	81349	RC07GF302J
R18	000132	RES	CARBON	1.3 K	5% 1/4W	81349	RC07GF132J
R19	000242	RES	CARBON	2.4 K	5% 1/4W	81349	RC07GF242J
R20	000132	RES	CARBON	1.3 K	5% 1/4W	81349	RC07GF132J
R21	000221	RES	CARBON	220 OHM	5% 1/4W	81349	RC07GF221J
R22	000132	RES	CARBON	1.3 K	5% 1/4W	81349	RC07GF132J
R23	000221	RES	CARBON	220 OHM	5% 1/4W	81349	RC07GF221J
R24	000103	RES	CARBON	10 K	5% 1/4W	81349	RC07GF103J
R25	000103	RES	CARBON	10 K	5% 1/4W	81349	RC07GF103J
R26	000221	RES	CARBON	220 OHM	5% 1/4W	81349	RC07GF221J
R27	000511	RES	CARBON	510 OHM	5% 1/4W	81349	RC07GF511J
R28	000103	RES	CARBON	10 K	5% 1/4W	81349	RC07GF103J
R29	000103	RES	CARBON	10 K	5% 1/4W	81349	RC07GF103J
R30	000103	RES	CARBON	10 K	5% 1/4W	81349	RC07GF103J
R31	000391	RES	CARBON	390 OHM	5% 1/4W	81349	RC07GF391J
R32	000181	RES	CARBON	180 OHM	5% 1/4W	81349	RC07GF181J
R33	000511	RES	CARBON	510 OHM	5% 1/4W	81349	RC07GF511J
R34	000511	RES	CARBON	510 OHM	5% 1/4W	81349	RC07GF511J
R35	000181	RES	CARBON	180 OHM	5% 1/4W	81349	RC07GF181J
R36	000391	RES	CARBON	390 OHM	5% 1/4W	81349	RC07GF391J
R37	000181	RES	CARBON	180 OHM	5% 1/4W	81349	RC07GF181J
R38	000391	RES	CARBON	390 OHM	5% 1/4W	81349	RC07GF391J
R39	000181	RES	CARBON	180 OHM	5% 1/4W	81349	RC07GF181J

406763 – Assy., PCB, MAIN LOGIC *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
R40	000391	RES CARBON 390 OHM 5% 1/4W	81349	RC07GF391J
R41	000391	RES CARBON 390 OHM 5% 1/4W	81349	RC07GF391J
R42	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R43	000511	RES CARBON 510 OHM 5% 1/4W	81349	RC07GF511J
R44	000391	RES CARBON 390 OHM 5% 1/4W	81349	RC07GF391J
R45	000181	RES CARBON 180 OHM 5% 1/4W	81349	RC07GF181J
R46	000471	RES CARBON 470 OHM 5% 1/4W	81349	RC07GF471J
R47	000430	RES CARBON 43 OHM 5% 1/4W	81349	RC07GF430J
R48	000910	RES CARBON 91 OHM 5% 1/4W	81349	RC07GF910J
R49	000132	RES CARBON 1.3 K 5% 1/4W	81349	RC07GF132J
R50	000471	RES CARBON 470 OHM 5% 1/4W	81349	RC07GF471J
R51	000430	RES CARBON 43 OHM 5% 1/4W	81349	RC07GF430J
R52	000430	RES CARBON 43 OHM 5% 1/4W	81349	RC07GF430J
R53	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GF302J
R54	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GF302J
R55	000132	RES CARBON 1.3 K 5% 1/4W	81349	RC07GF132J
R56	000132	RES CARBON 1.3 K 5% 1/4W	81349	RC07GF132J
R58	000430	RES CARBON 43 OHM 5% 1/4W	81349	RC07GF430J
R59	000221	RES CARBON 220 OHM 5% 1/4W	81349	RC07GF221J
R60	001759	RES CARBON 5.1 OHM 5% 1/4W	81349	RC07GF5R1J
R61	040224	POT CERMET 20 OHM 20%	73138	89P Series
R62	020666	RES WW .9 OHM 2% 3 W	91637	RS-2B
R63	000511	RES CARBON 510 OHM 5% 1/4W	81349	RC07GF511J
R64	000511	RES CARBON 510 OHM 5% 1/4W	81349	RC07GF511J
R65	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R66	000221	RES CARBON 220 OHM 5% 1/4W	81349	RC07GF221J
R67	000430	RES CARBON 43 OHM 5% 1/4W	81349	RC07GF430J
R68	000430	RES CARBON 43 OHM 5% 1/4W	81349	RC07GF430J
R70	000132	RES CARBON 1.3 K 5% 1/4W	81349	RC07GF132J
R71	000910	RES CARBON 91 OHM 5% 1/4W	81349	RC07GF910J
R72	000132	RES CARBON 1.3 K 5% 1/4W	81349	RC07GF132J
R73	000511	RES CARBON 510 OHM 5% 1/4W	81349	RC07GF511J
U1	230118	INTEGRATED CIRCUIT NPN	86884	CA3086
U2	230205	INTEGRATED CIRCUIT	04713	MC10102P
U3	230112	INTEGRATED CIRCUIT	04713	MC10131P
U4	230112	INTEGRATED CIRCUIT	04713	MC10131P
U5	230205	INTEGRATED CIRCUIT	04713	MC10102P
U6	230205	INTEGRATED CIRCUIT	04713	MC10102P
U7	230112	INTEGRATED CIRCUIT	04713	MC10131P
U8	230112	INTEGRATED CIRCUIT	04713	MC10131P
U9	230028	INTEGRATED CIRCUIT CERAM	01295	SN7400N

406763 -- Assy., PCB, MAIN LOGIC *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
U10	230072	INTEGRATED CIRCUIT CERAM	01295	SN7474N
U11	230064	INTEGRATED CIRCUIT CERAM	01295	SN7404N
U12	230205	INTEGRATED CIRCUIT	04713	MC10102P
U13	230205	INTEGRATED CIRCUIT	04713	MC10102P
U14	230205	INTEGRATED CIRCUIT	04713	MC10102P
U15	230206	INTEGRATED CIRCUIT	04713	MC10109P
U16	230206	INTEGRATED CIRCUIT	04713	MC10109P
U17	230205	INTEGRATED CIRCUIT	04713	MC10102P
U18	230030	INTEGRATED CIRCUIT CERAM	01295	SN7402N
U19	230028	INTEGRATED CIRCUIT CERAM	01295	SN7400N
U20	230037	INTEGRATED CIRCUIT PLASTIC	07263	SN7490N
U21	230112	INTEGRATED CIRCUIT	04713	MC10131P
U22	230112	INTEGRATED CIRCUIT	04713	MC10131P
U23	230112	INTEGRATED CIRCUIT	04713	MC10131P
U24	230112	INTEGRATED CIRCUIT	04713	MC10131P
U25	230112	INTEGRATED CIRCUIT	04713	MC10131P
U26	230064	INTEGRATED CIRCUIT CERAM	01295	SN7404N
U27	230028	INTEGRATED CIRCUIT CERAM	01295	SN7400N
U28	230173	INTEGRATED CIRCUIT	50088	MK5009P
U29	230250	INTEGRATED CIRCUIT	01295	SN7412N
U30	230028	INTEGRATED CIRCUIT CERAM	01295	SN7400N
U31	230189	INTEGRATED CIRCUIT	01295	SN74123N
U32	230212	INTEGRATED CIRCUIT	01295	SN74164N
U33	230212	INTEGRATED CIRCUIT	01295	SN74164N
U34	230212	INTEGRATED CIRCUIT	01295	SN74164N
U35	230064	INTEGRATED CIRCUIT CERAM	01295	SN7404N
U36	230072	INTEGRATED CIRCUIT CERAM	01295	SN7474N
U37	230028	INTEGRATED CIRCUIT CERAM	01295	SN7400N
U38	230217	INTEGRATED CIRCUIT	01295	SN74490N
U39	230217	INTEGRATED CIRCUIT	01295	SN74490N
U40	230217	INTEGRATED CIRCUIT	01295	SN74490N
U41	230217	INTEGRATED CIRCUIT	01295	SN74490N
U42	230210	INTEGRATED CIRCUIT	01295	SN74165N
U43	230064	INTEGRATED CIRCUIT CERAM	01295	SN7404N
U44	230099	INTEGRATED CIRCUIT CERAM	01295	SN7454N
U45	230028	INTEGRATED CIRCUIT CERAM	01295	SN7400N
U46	230210	INTEGRATED CIRCUIT	01295	SN74165N
U47	230210	INTEGRATED CIRCUIT	01295	SN74165N
U48	230210	INTEGRATED CIRCUIT	01295	SN74165N
U49	230210	INTEGRATED CIRCUIT	01295	SN74165N
U50	230028	INTEGRATED CIRCUIT CERAM	01295	SN7400N
U51	230144	INTEGRATED CIRCUIT	27014	LM309KC

406763 – Assy., PCB, MAIN LOGIC *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
U52	230144	INTEGRATED CIRCUIT	27014	LM309KC
U53	230144	INTEGRATED CIRCUIT	27014	LM309KC
U54	230203	INTEGRATED CIRCUIT	04713	MC7812CK
U55	230204	INTEGRATED CIRCUIT	27014	LM320K-12
U56	230144	INTEGRATED CIRCUIT	27014	LM309KC
Y1	730655	OSCILLATOR 10 MHz	21793	730655
Z1	080008	RES ARRAY 1 K	11237	761-3-R1K
Z2	080002	RES ARRAY 500 OHM	11237	750-81-R500
Z3	080002	RES ARRAY 500 OHM	11237	750-81-R500
Z4	080002	RES ARRAY 500 OHM	11237	750-81-R500
Z5	080002	RES ARRAY 500 OHM	11237	750-81-R500
Z6	080002	RES ARRAY 500 OHM	11237	750-81-R500
Z7	080002	RES ARRAY 500 OHM	11237	750-81-R500
Z8	080002	RES ARRAY 500 OHM	11237	750-81-R500
Z9	080010	RES ARRAY TTL to ECL	11237	761-45
Z10	080002	RES ARRAY 500 OHM	11237	750-81-R500
Z11	080002	RES ARRAY 500 OHM	11237	750-81-R500
Z12	080010	RES ARRAY TTL to ECL	11237	761-45
Z13	080010	RES ARRAY TTL to ECL	11237	761-45

406771 -- Assy., FRONT PANEL

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
A1	406799	CABLE ASSY., (REF: Front Panel to Signal Conditioners)	21793	406799
A2	406800	CABLE ASSY., (REF: Front Panel to Prescaler)	21793	406800
H1	610324	NUT, PRESS, #6 (8*)		
H2	610786	STANDOFF, SELF-CLINCHING, 4-40x3/4 (5*)		
H3	610787	STUD-PRESS, #6-32x5/16 (3*)		
H4	615042	SCREW, PPH, 4-40x1/4 (5*)		
H5	617016	NUT, HEX. LIGHT, #4 (3*)		
H6	617077	WASHER, LOCK, #4 (5*)		
H7	617102	WASHER, FLAT, LIGHT, #4 (5*)		
H8	730676	PANEL, STRUCT (1*)	21793	730676
H9	730679	LIGHT BLOCK (1*)	21793	730679
H10	730683	LIGHT BLOCK - DUAL (1*)	21793	730683
H11	730685	LIGHT BLOCK - SINGLE (1*)	21793	730685
S101	730305	SWITCH, POWER	21793	730305

*Quantity Required

406764 — Assy., PCB, DISPLAY

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
A1	406776	CABLE ASSY (MAIN LOGIC TO READOUT)	21793	406776
A2	406778	CABLE ASSY (READOUT TO COMPUTER)	21793	406778
A3	406779	CABLE ASSY (3-WIRE)	21793	406779
A4	406801	CABLE ASSY (3-WIRE SHORT)	21793	406801
C1	100017	CAP CERAM .01 MFD 100 V 20%	56289	TG-S10
C2	110141	CAP TANTA 22 MFD 15 V 20%	05397	T368B226M015AS
C3	100017	CAP CERAM .01 MFD 100 V 20%	56289	TG-S10
C4	110141	CAP TANTA 22 MFD 15 V 20%	05397	T368B226M015AS
C5	100017	CAP CERAM .01 MFD 100 V 20%	56289	TG-S10
C6	100017	CAP CERAM .01 MFD 100 V 20%	56289	TG-S10
C7	100017	CAP CERAM .01 MFD 100 V 20%	56289	TG-S10
CR1	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR2	210079	DIODE LAMP, HI INTENSITY, YELLOW	50434	HP5082-4555
CR3	210079	DIODE LAMP, HI INTENSITY, YELLOW	50434	HP5082-4555
CR4	210079	DIODE LAMP, HI INTENSITY, YELLOW	50434	HP5082-4555
CR5	210079	DIODE LAMP, HI INTENSITY, YELLOW	50434	HP5082-4555
CR6	210079	DIODE LAMP, HI INTENSITY, YELLOW	50434	HP5082-4555
CR7	210079	DIODE LAMP, HI INTENSITY, YELLOW	50434	HP5082-4555
CR8	210079	DIODE LAMP, HI INTENSITY, YELLOW	50434	HP5082-4555
CR9	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR10	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR11	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR12	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR13	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR14	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR15	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR16	210079	DIODE LAMP, HI INTENSITY, YELLOW	50434	HP5082-4555
CR17	210080	DIODE LAMP, HI INTENSITY, RED	50434	HP5082-4665
CR18	210080	DIODE LAMP, HI INTENSITY, RED	50434	HP5082-4665
CR19	210079	DIODE LAMP, HI INTENSITY, YELLOW	50434	HP5082-4555
CR20	210079	DIODE LAMP, HI INTENSITY, YELLOW	50434	HP5082-4555
CR21	210079	DIODE LAMP, HI INTENSITY, YELLOW	50434	HP5082-4555
CR22	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR23	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR24	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR25	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR26	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR27	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR28	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR29	210071	DIODE LAMP, LED, RED	50434	HP5082-4650

406764 – Assy., PCB, DISPLAY *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
CR30	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR31	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR32	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR33	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR34	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR35	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR36	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR37	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR38	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR39	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR40	210079	DIODE LAMP, HI INTENSITY, YELLOW	50434	HP5082-4555
CR41	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR42	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR43	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR44	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR45	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
CR46	210071	DIODE LAMP, LED, RED	50434	HP5082-4650
H1	920419	SOCKET IC, 16 PIN (10*)		CA-16S-TSD-E
H2	920460	SOCKET IC, 14 PIN (14*)		CA-14S-TSD-E
H3	920624	SOCKET IC, 24 PIN (1*)	71785	133-59-02-063
H4	920648	SPACER (REF.: LED 12, 13, 14) (3*)		SA310014-B
H5	920778	SOCKET IC, 14 PIN (REF.: LED 12, 13, 14) (3*)		CA-14S-101WW
LED 1	210074	DIODE DISPLAY, LED, YELLOW	50434	HP5082-7660
LED 2	210074	DIODE DISPLAY, LED, YELLOW	50434	HP5082-7660
LED 3	210074	DIODE DISPLAY, LED, YELLOW	50434	HP5082-7660
LED 4	210074	DIODE DISPLAY, LED, YELLOW	50434	HP5082-7660
LED 5	210074	DIODE DISPLAY, LED, YELLOW	50434	HP5082-7660
LED 6	210074	DIODE DISPLAY, LED, YELLOW	50434	HP5082-7660
LED 7	210074	DIODE DISPLAY, LED, YELLOW	50434	HP5082-7660
LED 8	210074	DIODE DISPLAY, LED, YELLOW	50434	HP5082-7660
LED 9	210074	DIODE DISPLAY, LED, YELLOW	50434	HP5082-7660
LED 10	210074	DIODE DISPLAY, LED, YELLOW	50434	HP5082-7660
LED 11	210074	DIODE DISPLAY, LED, YELLOW	50434	HP5082-7660
LED 12	210060	DIODE DISPLAY, LED, RED	50434	HP5082-7730
LED 13	210075	DIODE DISPLAY, LED, ARRAY	50434	HP5082-7433
LED 14	210075	DIODE DISPLAY, LED, ARRAY	50434	HP5082-7433

*Quantity Required

406764 – Assy., PCB, DISPLAY *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
Q1	200184	TRANS PNP	04713	MPSA55
Q2	200184	TRANS PNP	04713	MPSA55
Q3	200184	TRANS PNP	04713	MPSA55
Q4	200184	TRANS PNP	04713	MPSA55
Q5	200184	TRANS PNP	04713	MPSA55
Q6	200184	TRANS PNP	04713	MPSA55
Q7	200184	TRANS PNP	04713	MPSA55
Q8	200184	TRANS PNP	04713	MPSA55
Q9	200184	TRANS PNP	04713	MPSA55
Q10	200184	TRANS PNP	04713	MPSA55
Q11	200184	TRANS PNP	04713	MPSA55
Q12	200184	TRANS PNP	04713	MPSA55
Q13	200184	TRANS PNP	04713	MPSA55
Q14	200184	TRANS PNP	04713	MPSA55
Q15	200239	TRANS NPN	01295	TIS99
Q16	200239	TRANS NPN	01295	TIS99
Q17	200239	TRANS NPN	01295	TIS99
Q18	200239	TRANS NPN	01295	TIS99
Q19	200239	TRANS NPN	01295	TIS99
Q20	200239	TRANS NPN	01295	TIS99
Q21	200239	TRANS NPN	01295	TIS99
Q22	200184	TRANS PNP	04713	MPSA55
Q23	200184	TRANS PNP	04713	MPSA55
Q24	200184	TRANS PNP	04713	MPSA55
Q25	200184	TRANS PNP	04713	MPSA55
Q26	200239	TRANS NPN	01295	TIS99
Q27	200239	TRANS NPN	01295	TIS99
Q28	200239	TRANS NPN	01295	TIS99
Q29	200239	TRANS NPN	01295	TIS99
Q30	200239	TRANS NPN	01295	TIS99
Q31	200239	TRANS NPN	01295	TIS99
Q32	200239	TRANS NPN	01295	TIS99
Q33	200088	TRANS SILICO PNP	80131	2N4248
Q34	200088	TRANS SILICO PNP	80131	2N4248
Q35	200088	TRANS SILICO PNP	80131	2N4248
Q36	200088	TRANS SILICO PNP	80131	2N4248
Q37	200088	TRANS SILICO PNP	80131	2N4248
Q38	200088	TRANS SILICO PNP	80131	2N4248
Q39	200088	TRANS SILICO PNP	80131	2N4248
R1	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R2	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J

406764 – Assy., PCB, DISPLAY *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
R3	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R4	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R5	000221	RES CARBON 220 OHM 5% 1/4W	81349	RC07GF221J
R6	000221	RES CARBON 220 OHM 5% 1/4W	81349	RC07GF221J
R7	000221	RES CARBON 220 OHM 5% 1/4W	81349	RC07GF221J
R8	000330	RES CARBON 33 OHM 5% 1/4W	81349	RC07GF330J
R9	001775	RES CARBON 33 OHM 5% 1 W	81349	RC32GF330J
R10	001775	RES CARBON 33 OHM 5% 1 W	81349	RC32GF330J
R11	001775	RES CARBON 33 OHM 5% 1 W	81349	RC32GF330J
R12	001775	RES CARBON 33 OHM 5% 1 W	81349	RC32GF330J
R13	001775	RES CARBON 33 OHM 5% 1 W	81349	RC32GF330J
R14	001775	RES CARBON 33 OHM 5% 1 W	81349	RC32GF330J
R15	001775	RES CARBON 33 OHM 5% 1 W	81349	RC32GF330J
R16	000221	RES CARBON 220 OHM 5% 1/4W	81349	RC07GF221J
R17	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R18	000221	RES CARBON 220 OHM 5% 1/4W	81349	RC07GF221J
R19	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R20	000221	RES CARBON 220 OHM 5% 1/4W	81349	RC07GF221J
R21	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R22	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
R23	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
R24	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
R25	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
R26	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R27	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R28	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R29	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R30	000681	RES CARBON 680 OHM 5% 1/4W	81349	RC07GF681J
TP5	600786	TEST POINT	00779	1-87022-0
TP6	600786	TEST POINT	00779	1-87022-0
U1	230208	INTEGRATED CIRCUIT	01295	SN74154N
U2	230209	INTEGRATED CIRCUIT	01295	SN7448N
U3	230065	INTEGRATED CIRCUIT PLASTIC	07263	SN7475N
U4	230074	INTEGRATED CIRCUIT PLASTIC	07263	SN7442N
U5	230065	INTEGRATED CIRCUIT PLASTIC	07263	SN7475N
U6	230074	INTEGRATED CIRCUIT PLASTIC	07263	SN7442N
U7	230065	INTEGRATED CIRCUIT PLASTIC	07263	SN7475N
U8	230065	INTEGRATED CIRCUIT PLASTIC	07263	SN7475N
U9	230065	INTEGRATED CIRCUIT PLASTIC	07263	SN7475N
U10	230065	INTEGRATED CIRCUIT PLASTIC	07263	SN7475N

406764 – Assy., PCB, DISPLAY *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
U11	230209	INTEGRATED CIRCUIT	01295	SN7448N
U12	230030	INTEGRATED CIRCUIT CERAM	01295	SN7402N
U13	230099	INTEGRATED CIRCUIT CERAM	01295	SN7454N
U14	230030	INTEGRATED CIRCUIT CERAM	01295	SN7402N
W1	600245	JUMPER		L-2007-1LP
Z1	080003	RES ARRAY 2 K	11237	750-81-R2K
Z2	080007	RES ARRAY 220 OHM	11237	761-3-R220
Z3	080007	RES ARRAY 220 OHM	11237	761-3-R220
Z4	080003	RES ARRAY 2 K	11237	750-81-R2K
Z5	080011	RES ARRAY 1 K	11237	750-81-R1K
Z6	080000	RES ARRAY 220 OHM	11237	750-81-R220
Z7	080000	RES ARRAY 220 OHM	11237	750-81-R220
Z8	080006	RES ARRAY 68 OHM	11237	761-3-R68
Z9	080000	RES ARRAY 220 OHM	11237	750-81-R220

406772 -- Assy., REAR PANEL

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
A1	406781	ASSY CABLE, AC POWER SWITCH	21793	406781
C201	100111	CAP CERAM .01 MFD 2000 V	71471	HVD6-2KV
C202	100111	CAP CERAM .01 MFD 2000 V	71471	HVD6-2KV
F101	920775	FAN	32284	SUZA1
F201	920776	FUSE SLO-BLO 1-1/4 AMP	71400	HDX1-1/4
H1	610140	STANDOFF, SWAGE, 4-40 (1*)		
H2	610180	CABLE CLAMP (1*)		
H3	610182	CABLE CLAMP (1*)		
H4	610216	PRESSNUT, 3-48 (4*)		
H5	730187	BRACKET, FAN (2*)	21793	730187
H6	730656	STIFFENER, PC BOARD (1*)	21793	730656
H7	730664	RETAINER, FILTER (1*)	21793	730664
H8	730665	FILTER, AIR (1*)	21793	730665
H9	730666	BUTCH PLATE (2*)	21793	730666
H10	730670	ADAPTER PLATE (1*)	21793	730670
H11	730671	SPACER, TRANSFORMER (1*)	21793	730671
H12	920573	PLUG, HOLE (2*)	28520	P-437
H13	920574	PLUG, HOLE (REF: J207, J208, J209) (3*)	28520	P-562
H14	610389	GROMMET, 1/16 x 2.5 ± .2 LG (1*)		
H15	615028	SCREW, PPH, 3-48 x 1/4 LG (4*)		
H16	615042	SCREW, PPH, 4-40 x 1/4 LG (4*)		
H17	615046	SCREW, PPH, 4-40 x 1/2 LG (1*)		
H18	615057	SCREW, PPH, 6-32 x 1/4 LG (4*)		
H19	617079	LOCKWASHER #6 (4*)		
H20	617102	WASHER, FLAT #4 (1*)		
J201	600808	CONN BNC	02660	31-010
J202	600808	CONN BNC	02660	31-010
J203	600808	CONN BNC	02660	31-010
J204	600808	CONN BNC	02660	31-010
J205	600808	CONN BNC	02660	31-010
J206	600808	CONN BNC	02660	31-010
J210	600795	CONN		6J1
J213	600808	CONN BNC	02660	31-010
J214	600586	BINDING POST, WHITE	32767	820-25
J215	600587	BINDING POST, BLACK	32767	820-45
J216	600586	BINDING POST, WHITE	32767	820-25

*Quantity Required

406772 – Assy., REAR PANEL *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
T201	730669	TRANSFORMER	21793	730669
W101	600245	JUMPER		L-2007-1LP
W102	600245	JUMPER		L-2007-1LP

406773 – Assy., KEYBOARD

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
A1	406774	ASSY., KEYBOARD, PCB	21793	406774
H1	610798	SCREW, FHP, SELF-TAPPING (4*)		
H2	730672	BOTTOM, KEYBOARD (1*)	21793	730672
H3	730673	INSTRUCTION PLATE (1*)	21793	730673
H4	730674	CASE, KEYBOARD (1*)	21793	730674
H5	730684	DECAL-INSTRUCTION (1*)	21793	730684

*Quantity Required

406774 – Assy., PCB, KEYBOARD

REE DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
CR5	211083	DIODE SILICO 018	21793	211083
CR6	211083	DIODE SILICO 018	21793	211083
CR7	211083	DIODE SILICO 018	21793	211083
CR8	211083	DIODE SILICO 018	21793	211083
CR9	211083	DIODE SILICO 018	21793	211083
P14	600802	CONN HEADER 26 PINS	28218	3429-1002
S1	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S2	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S3	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S4	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S5	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S6	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S7	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S8	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S9	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S10	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S11	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S12	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S13	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S14	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S15	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S16	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S17	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S18	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S19	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S20	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S21	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S22	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S23	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S24	600804	SWITCH SLIDE 1 POL 2 POS	79727	GF124-3W/G-20-60
S25	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S26	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S27	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S28	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S29	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S30	600804	SWITCH SLIDE 1 POL 2 POS	79727	GF124-3W/G-20-60
S31	600804	SWITCH SLIDE 1 POL 2 POS	79727	GF124-3W/G-20-60
S32	600804	SWITCH SLIDE 1 POL 2 POS	79727	GF124-3W/G-20-60
S33	600804	SWITCH SLIDE 1 POL 2 POS	79727	GF124-3W/G-20-60
S34	600805	SWITCH SLIDE 1 POL 2 POS	79727	G-127L-3W/G-20-50

406774 – Assy., PCB, KEYBOARD *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
S35	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S36	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S37	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
S38	600807	SWITCH PUSHBUTTON SPST	29090	LM Series
U1	230214	INTEGRATED CIRCUIT 16 PIN	34649	4003

406767 – Assy., PCB, DAC

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
C1	100103	CAP CERAM 68 PFD 1000 V 5%	56289	C030B101F680J
C2	100103	CAP CERAM 68 PFD 1000 V 5%	56289	C030B101F680J
C3	100103	CAP CERAM 68 PFD 1000 V 5%	56289	C030B101F680J
C4	100017	CAP CERAM .01 MFD 100 V 20%	56289	TG-S10
C5	100017	CAP CERAM .01 MFD 100 V 20%	56289	TG-S10
C6	100103	CAP CERAM 68 PFD 1000 V 5%	56289	C030B101F680J
C7	110151	CAP TANTA 10 MFD 35 V 20%	05397	T362C106M035A
C8	110151	CAP TANTA 10 MFD 35 V 20%	05397	T362C106M035A
H1	610487	MOUSETAIL (1*)	98159	2829-75-3
H2	920460	SOCKET, IC, 14 PIN (REF: U1, U2, U3, U6, U7) (5*)		CA-14S-TSD-E
H3	920419	SOCKET, IC, 16 PIN (REF: U4, U5) (2*)		CA-16S-TSD-E
H4	920585	CUP, ENCAPSULATION, PLASTIC (1*)		NC-731-57135
J2-1	600787	RECPTLE BOARD MOUNT	00779	85863-3
J2-2	600787	RECPTLE BOARD MOUNT	00779	85863-3
J2-3	600787	RECPTLE BOARD MOUNT	00779	85863-3
J2-4	600149	RECPTLE BLUE	74970	105-760
J2-5	600787	RECPTLE BOARD MOUNT	00779	85863-3
J2-6	600787	RECPTLE BOARD MOUNT	00779	85863-3
J2-7	600787	RECPTLE BOARD MOUNT	00779	85863-3
J2-8	600787	RECPTLE BOARD MOUNT	00779	85863-3
J2-9	600787	RECPTLE BOARD MOUNT	00779	85863-3
J2-10	600787	RECPTLE BOARD MOUNT	00779	85863-3
J2-11	600149	RECPTLE BLUE	74970	105-760
Q1	200068	TRANS	80131	2N4250
Q2	200068	TRANS	80131	2N4250
Q3	200068	TRANS	80131	2N4250
Q4	200200	TRANS NPN	21793	200200
Q5	200200	TRANS NPN	21793	200200
Q6	200068	TRANS	80131	2N4250
R1	000392	RES CARBON 3.9 K 5% 1/4W	81349	RC07GF392J
R2	012004	RES METAL 4.12 K 1%	81349	RN55C4121F
R3	040187	POT CERMET 500 OHM 20%	11237	360T501B
R4	040187	POT CERMET 500 OHM 20%	11237	360T501B
R5	012004	RES METAL 4.12 K 1%	81349	RN55C4121F
R6	000392	RES CARBON 3.9 K 5% 1/4W	81349	RC07GF392J
R7	000392	RES CARBON 3.9 K 5% 1/4W	81349	RC07GF392J

*Quantity Required

406767 – Assy., PCB, DAC *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
R8	000392	RES CARBON 3.9 K 5% 1/4W	81349	RC07GF392J
R9	000513	RES CARBON 51 K 5% 1/4W	81349	RC07GF513J
R10	000392	RES CARBON 3.9 K 5% 1/4W	81349	RC07GF392J
R11	000392	RES CARBON 3.9 K 5% 1/4W	81349	RC07GF392J
R12	000513	RES CARBON 51 K 5% 1/4W	81349	RC07GF513J
R13	000162	RES CARBON 1.6 K 5% 1/4W	81349	RC07GF162J
R14	012003	RES METAL 1.91 K 1%	81349	RN55C1911F
R15	040187	POT CERMET 500 OHM 20%	11237	360T501B
R16	040187	POT CERMET 500 OHM 20%	11237	360T501B
R17	012003	RES METAL 1.91 K 1%	81349	RN55C1911F
R18	000162	RES CARBON 1.6 K 5% 1/4W	81349	RC07GF162J
R19	010649	RES METAL 2 K 1% 1/10W	81349	RN55D2001F
R20	010649	RES METAL 2 K 1% 1/10W	81349	RN55D2001F
R21	010821	RES METAL 5.36 K 1% 1/10W	81349	RN55C
R22	000162	RES CARBON 1.6 K 5% 1/4W	81349	RC07GF162J
R23	010969	RES 1.62 K 1%	81349	RN55C
R24	010969	RES 1.62 K 1%	81349	RN55C
R25	000162	RES CARBON 1.6 K 5% 1/4W	81349	RC07GF162J
R26	000162	RES CARBON 1.6 K 5% 1/4W	81349	RC07GF162J
R27	000162	RES CARBON 1.6 K 5% 1/4W	81349	RC07GF162J
R28	000200	RES CARBON 20 OHM 5% 1/4W	81349	RC07GF200J
U1	230212	INTEGRATED CIRCUIT	01295	SN74164N
U2	230072	INTEGRATED CIRCUIT CERAM	01295	SN7474N
U3	230212	INTEGRATED CIRCUIT	01295	SN74164N
U4	230207	INTEGRATED CIRCUIT	04713	MC1408L8
U5	230207	INTEGRATED CIRCUIT	04713	MC1408L8
U6	230118	INTEGRATED CIRCUIT	86884	CA3086
U7	230190	INTEGRATED CIRCUIT OP AMP	27014	LM324
W1	600245	JUMPER		L-2007-1LP
W2	600245	JUMPER		L-2007-1LP

406768 – Assy., PCB, REFERENCE

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
C1	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C2	100053	CAP	CERAM	56 PFD	1000 V	5%	56289	10TCCQ56
C3	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C4	100051	CAP	CERAM	3 PFD	500 V		71471	TCD-B1-0
C5	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C6	100050	CAP	CERAM	2.2 PFD	1000 V	5%	56289	10TCCV22
C7	110151	CAP	TANTA	10 MFD	35 V	20%	05397	T362C106M035A
C8	100097	CAP	CERAM	12 PFD	500 V	5%	56289	C030B102F120J
C9	100018	CAP	CERAM	120 PFD	500 V	10%	71471	ETCD(N5600)
C10	100038	CAP	CERAM	560 PFD	500 V	10%	71590	DD561
C11	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C12	110141	CAP	TANTA	22 MFD	15 V	20%	05397	T368B226M015AS
C13	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C14	110141	CAP	TANTA	22 MFD	15 V	20%	05397	T368B226M015AS
C15	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C16	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C17	110141	CAP	TANTA	22 MFD	15 V	20%	05397	T368B226M015AS
C18	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C19	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C20	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C21	100006	CAP	CERAM	10 PFD	500 V		71471	TCDI-1(N750)
C22	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C23	130052	CAP	VARIABLE	2-8 PFD			72982	538006A2-8
C24	100097	CAP	CERAM	12 PFD	500 V	5%	56289	C030B102F120J
C25	100009	CAP	CERAM	5 PFD	500 V	10%	71471	TCDI-1(N750)
C26	110151	CAP	TANTA	10 MFD	35 V	20%	05397	T362C106M035A
C27	100006	CAP	CERAM	10 PFD	500 V		71471	TCDI-1(N750)
C28	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C29	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C30	130052	CAP	VARIABLE	2-8 PFD			72982	538006A2-8
C31	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C32	100097	CAP	CERAM	12 PFD	500 V	5%	56289	C030B102F120J
C33	100072	CAP	CERAM	3.3 PFD	1000 V	10%	56289	C030B102E3R3D
C34	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C35	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C36	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
CR1	211083	DIODE	SILICO		018		21793	211083
CR2	211083	DIODE	SILICO		018		21793	211083
CR3	211083	DIODE	SILICO		018		21793	211083
CR4	211083	DIODE	SILICO		018		21793	211083
CR5	211083	DIODE	SILICO		018		21793	211083

406768 -- Assy., PCB, REFERENCE *continued*

REF DES	DANA P/N	DESCRIPTION				FSC	MANU P/N
H1	920734	SOCKET, IC, 14 PIN (2*)				71785	133-51-02-003
J5-1	600149	RECPTLE	BLUE			74970	105-760
J5-2	600787	RECPTLE	BOARD MOUNT			00779	85863-3
J5-3	600787	RECPTLE	BOARD MOUNT			00779	85863-3
J5-4	600149	RECPTLE	BLUE			74970	105-760
J5-5	600787	RECPTLE	BOARD MOUNT			00779	85863-3
J5-6	600787	RECPTLE	BOARD MOUNT			00779	85863-3
J5-7	600787	RECPTLE	BOARD MOUNT			00779	85863-3
J5-8	600787	RECPTLE	BOARD MOUNT			00779	85863-3
J5-9	600787	RECPTLE	BOARD MOUNT			00779	85863-3
J5-10	600787	RECPTLE	BOARD MOUNT			00779	85863-3
J5-11	600787	RECPTLE	BOARD MOUNT			00779	85863-3
J5-12	600149	RECPTLE	BLUE			74970	105-760
L1	310072	CHOKE	RF	2.2 µH	10%	99800	1537-20
L2	310126	CHOKE	RF	.39 µH	10%	24226	10/390µH±10%
L3	310062	CHOKE	RF	22 µH		99800	1537-44
L4	310092	CHOKE	RF	.1 µH		76493	9230-94
L5	310062	CHOKE	RF	22 µH		99800	1537-44
Q1	200037	TRANS	SILICO	NPN		80131	2N3646
Q2	200037	TRANS	SILICO	NPN		80131	2N3646
Q3	200037	TRANS	SILICO	NPN		80131	2N3646
Q4	200037	TRANS	SILICO	NPN		80131	2N3646
Q5	200037	TRANS	SILICO	NPN		80131	2N3646
Q6	200037	TRANS	SILICO	NPN		80131	2N3646
Q7	200037	TRANS	SILICO	NPN		80131	2N3646
Q8	200200	TRANS		NPN		21793	200200
Q9	200037	TRANS	SILICO	NPN		80131	2N3646
Q10	200200	TRANS		NPN		21793	200200
Q11	200037	TRANS	SILICO	NPN		80131	2N3646
Q12	200195	TRANS	SILICO	NPN		81349	2N5179
Q13	200195	TRANS	SILICO	NPN		81349	2N5179
Q14	200037	TRANS	SILICO	NPN		80131	2N3646
R1	000122	RES	CARBON	1.2 K	5% 1/4W	81349	RC07GF122J
R2	000302	RES	CARBON	3 K	5% 1/4W	81349	RC07GF302J
R3	000102	RES	CARBON	1 K	5% 1/4W	81349	RC07GF102J

*Quantity Required

406768 – Assy., PCB, REFERENCE *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
R4	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R5	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R6	000122	RES CARBON 1.2 K 5% 1/4W	81349	RC07GF122J
R7	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GF302J
R8	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GF302J
R9	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R10	000510	RES CARBON 51 OHM 5% 1/4W	81349	RC07GF510J
R11	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R12	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R13	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R14	000201	RES CARBON 200 OHM 5% 1/4W	81349	RC07GF201J
R15	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R16	000511	RES CARBON 510 OHM 5% 1/4W	81349	RC07GF511J
R17	000511	RES CARBON 510 OHM 5% 1/4W	81349	RC07GF511J
R18	000122	RES CARBON 1.2 K 5% 1/4W	81349	RC07GF122J
R19	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R20	000511	RES CARBON 510 OHM 5% 1/4W	81349	RC07GF511J
R21	000101	RES CARBON 100 OHM 5% 1/4W	81349	RC07GF101J
R22	000101	RES CARBON 100 OHM 5% 1/4W	81349	RC07GF101J
R23	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R24	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R25	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R26	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R27	000101	RES CARBON 100 OHM 5% 1/4W	81349	RC07GF101J
R28	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R29	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R30	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R31	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R32	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R33	000101	RES CARBON 100 OHM 5% 1/4W	81349	RC07GF101J
R34	000200	RES CARBON 20 OHM 5% 1/4W	81349	RC07GF200J
R35	000241	RES CARBON 240 OHM 5% 1/4W	81349	RC07GF241J
R36	000200	RES CARBON 20 OHM 5% 1/4W	81349	RC07GF200J
R37	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
TP1	600786	TEST POINT	00779	1-87022-0
TP2	600786	TEST POINT	00779	1-87022-0
TP3	600786	TEST POINT	00779	1-87022-0
U1	230064	INTEGRATED CIRCUIT CERAM	01295	SN7404N
U2	230028	INTEGRATED CIRCUIT CERAM	01295	SN7400N
Y1	920583	CRYSTAL 9998.800 kHz	21793	920583

406769 -- Assy., PCB, COMPUTER III

REE DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
C1	110141	CAP	TANTA	22 MFD	15 V	20%	05397	T368B226M015AS
C2	110141	CAP	TANTA	22 MFD	15 V	20%	05397	T368B226M015AS
C3	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C4	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C5	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C6	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C7	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C8	100017	CAP	CERAM	.01 MED	100 V	20%	56289	TG-S10
C9	100017	CAP	CERAM	.01 MED	100 V	20%	56289	TG-S10
C10	100017	CAP	CERAM	.01 MED	100 V	20%	56289	TG-S10
C11	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C12	100017	CAP	CERAM	.01 MED	100 V	20%	56289	TG-S10
C13	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C14	110143	CAP	TANTA	1 MFD	35 V		05397	T368A105M035AS
C15	110143	CAP	TANTA	1 MFD	35 V		05397	T368A105M035AS
C16	110141	CAP	TANTA	22 MFD	15 V	20%	05397	T368B226M015AS
C17	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C18	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C19	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C20	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C21	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C22	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C23	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
CR1	211083	DIODE	SILICO		018		21793	211083
H1	920419	SOCKET, IC, 16 PIN (23*)						CA-16S-TSD-E
H2	920460	SOCKET, IC, 14 PIN (13*)						CA-14S-TSD-E
J7-1	600149	RECPTLE	BLUE				74970	105-760
J7-12	600787	RECPTLE	BOARD MOUNT				00779	85863-3
J7-13	600787	RECPTLE	BOARD MOUNT				00779	85863-3
J7-14	600787	RECPTLE	BOARD MOUNT				00779	85863-3
J7-15	600787	RECPTLE	BOARD MOUNT				00779	85863-3
J7-16	600787	RECPTLE	BOARD MOUNT				00779	85863-3
J7-17	600787	RECPTLE	BOARD MOUNT				00779	85863-3
J7-18	600787	RECPTLE	BOARD MOUNT				00779	85863-3
J7-19	600787	RECPTLE	BOARD MOUNT				00779	85863-3
J7-20	600787	RECPTLE	BOARD MOUNT				00779	85863-3
J7-21	600787	RECPTLE	BOARD MOUNT				00779	85863-3

*Quantity Required

406769 – Assy., PCB, COMPUTER III *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
J7-22	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-23	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-24	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-25	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-26	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-27	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-28	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-29	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-30	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-31	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-32	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-33	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-34	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-35	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-36	600149	RECPTLE BLUE	74970	105-760
J7-37	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-38	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-39	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-41	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-45	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-46	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-47	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-48	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-49	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-61	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-62	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-63	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-64	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-65	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-66	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-67	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-68	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-69	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-70	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-71	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-72	600149	RECPTLE BLUE	74970	105-760
J7-73	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-74	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-75	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-76	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-77	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7-78	600787	RECPTLE BOARD MOUNT	00779	85863-3

406769 -- Assy., PCB, COMPUTER III *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
Q1	200200	TRANS NPN	21793	200200
R1	000472	RES CARBON 4.7 K 5% 1/4W	81349	RC07GF472J
R2	000471	RES CARBON 470 OHM 5% 1/4W	81349	RC07GF471J
R3	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R4	000200	RES CARBON 20 OHM 5% 1/4W	81349	RC07GF200J
R5	000200	RES CARBON 20 OHM 5% 1/4W	81349	RC07GF200J
R6	00024I	RES CARBON 240 OHM 5% 1/4W	81349	RC07GF241J
R7	00024I	RES CARBON 240 OHM 5% 1/4W	81349	RC07GF241J
R8	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R9	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R10	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R11	000472	RES CARBON 4.7 K 5% 1/4W	81349	RC07GF472J
R12	000472	RES CARBON 4.7 K 5% 1/4W	81349	RC07GF472J
R13	00047I	RES CARBON 470 OHM 5% 1/4W	81349	RC07GF471J
R14	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R15	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R16	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R17	000103	RES CARBON 10 K 5% 1/4W	81349	RC07GF103J
R18	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
TP1	600786	TEST POINT	00779	1-87022-0
TP2	600786	TEST POINT	00779	1-87022-0
U1	230216	INTEGRATED CIRCUIT	01295	SN7489N
U2	230211	INTEGRATED CIRCUIT	01295	SN74161N
U3	230073	INTEGRATED CIRCUIT	01295	SN7405N
U4	230216	INTEGRATED CIRCUIT	01295	SN7489N
U5	230037	INTEGRATED CIRCUIT	01295	SN7490N
U6	230105	INTEGRATED CIRCUIT	01295	SN7417
U7	230037	INTEGRATED CIRCUIT	01295	SN7490N
U8	230159	INTEGRATED CIRCUIT	01295	SN7473N
U9	230213	INTEGRATED CIRCUIT	34649	4002-1
U10	230213	INTEGRATED CIRCUIT	34649	4002-1
U11	230159	INTEGRATED CIRCUIT	01295	SN7473N
U12	230215	INTEGRATED CIRCUIT	34649	4004
U13	230159	INTEGRATED CIRCUIT	01295	SN7473N
U14	230252	INTEGRATED CIRCUIT	34649	4001-1
U15	230181	INTEGRATED CIRCUIT	01295	SN7408J
U16	230254	INTEGRATED CIRCUIT	34649	4001-3
U17	230220	INTEGRATED CIRCUIT	27014	MH0026CN
U18	230251	INTEGRATED CIRCUIT	34649	4001-0

406769 — Assy., PCB, COMPUTER III *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
U19	230253	INTEGRATED CIRCUIT	34649	4001-2
U20	230105	INTEGRATED CIRCUIT	01295	SN7417
U21	230255	INTEGRATED CIRCUIT	34649	4001-4
U22	230256	INTEGRATED CIRCUIT	34649	4001-5
U23	230105	INTEGRATED CIRCUIT	01295	SN7417
U24	230257	INTEGRATED CIRCUIT	34649	4001-6
U25	230105	INTEGRATED CIRCUIT	01295	SN7417
U26	230258	INTEGRATED CIRCUIT	34649	4001-7
U27	230223	INTEGRATED CIRCUIT	34649	4001-8
U28	230105	INTEGRATED CIRCUIT	01295	SN7417
U29	230224	INTEGRATED CIRCUIT	34649	4001-9
U32	230105	INTEGRATED CIRCUIT	01295	SN7417
Z1	080004	RES ARRAY 4.7 K	11237	750-61-R4.7K
Z2	080004	RES ARRAY 4.7 K	11237	750-61-R4.7K
Z3	080005	RES ARRAY 10 K	11237	750-61-R10K
Z4	080005	RES ARRAY 10 K	11237	750-61-R10K
Z5	080005	RES ARRAY 10 K	11237	750-61-R10K
Z6	080004	RES ARRAY 4.7 K	11237	750-61-R4.7K
Z7	080005	RES ARRAY 10 K	11237	750-61-R10K
Z8	080004	RES ARRAY 4.7 K	11237	750-61-R4.7K
Z9	080005	RES ARRAY 10 K	11237	750-61-R10K
Z10	080004	RES ARRAY 4.7 K	11237	750-61-R4.7K
Z11	080005	RES ARRAY 10 K	11237	750-61-R10K
Z12	080004	RES ARRAY 4.7 K	11237	750-61-R4.7K
Z13	080005	RES ARRAY 10 K	11237	750-61-R10K
Z14	080004	RES ARRAY 4.7 K	11237	750-61-R4.7K

406765 – Assy., SIGNAL CONDITIONER "A"

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
C1	100063	CAP	CERAM	.01 MFD	500 V	20%	56289	5GAS-S10
C2	100079	CAP	CERAM	3.9 PFD	1000 V		56289	10TCCV39
C3	130146	CAP	VARIABLE	.25-1.5 PFD			74970	273-0001-002
C4	100119	CAP	CERAM	470 PFD	100 V	5%	72982	8121-100-C0G0471J
C5	100085	CAP	CERAM	6.8 PFD	1000 V		56289	10TCCV68
C6	130146	CAP	VARIABLE	.25-1.5 PFD			74970	273-0001-002
C7	100102	CAP	CERAM	47 PFD	1000 V	5%	56289	C030B101F470J
C8	100120	CAP	CERAM	270 PFD	1000 V		56289	C023B102E271M
C9	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C10	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C11	110151	CAP	TANTA	10 MFD	35 V	20%	05397	T362C106M035A
C12	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C13	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C14	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C15	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C16	110151	CAP	TANTA	10 MFD	35 V	20%	05397	T362C106M035A
C17	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C18	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C19	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C20	110141	CAP	TANTA	22 MFD	15 V	20%	05397	T368B226M015AS
C21	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C22	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C23	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C24	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C25	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C26	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
CR2	211083	DIODE	SILICO		018		21793	211083
CR3	211083	DIODE	SILICO		018		21793	211083
CR4	211083	DIODE	SILICO		018		21793	211083
CR5	211083	DIODE	SILICO		018		21793	211083
CR6	211083	DIODE	SILICO		018		21793	211083
CR7	211083	DIODE	SILICO		018		21793	211083
CR8	220031	DIODE	SILICO	ZENER	3.3 V		04713	1/4M3.3AZ5
CR9	220031	DIODE	SILICO	ZENER	3.3 V		04713	1/4M3.3AZ5
CR10	211236	DIODE	SILICO		007		21793	211236
CR11	211236	DIODE	SILICO		007		21793	211236
CR12	210064	DIODE	Matched Pair		018		21793	210064
CR13	210064	DIODE	Matched Pair		018		21793	210064
CR14	211083	DIODE	SILICO		018		21793	211083

406765 – Assy., SIGNAL CONDITIONER "A" *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
H1	600767	TERMINAL, TEFLON (2*)	98291	013-1400
H2	600786	POST (1*)	00779	1-87022-0
H3	610792	STANDOFF, SWG, THD, #2-56x .125 (3*)		
H4	610793	SPACER, SWG-ON, .438" LG (3*)		
H5	615019	SCREW, #2-56x5/8 LG (3*)		
H6	730681	SHIELD (2*)	21793	730681
H7	920734	SOCKET, IC, 14 PIN (4*)	71785	133-51-02-003
J4-1	600149	RECPTLE BLUE	74970	105-760
J4-2	600787	RECPTLE BOARD MOUNT	00779	85863-3
J4-3	600787	RECPTLE BOARD MOUNT	00779	85863-3
J4-4	600787	RECPTLE BOARD MOUNT	00779	85863-3
J4-5	600787	RECPTLE BOARD MOUNT	00779	85863-3
J4-6	600787	RECPTLE BOARD MOUNT	00779	85863-3
J4-7	600787	RECPTLE BOARD MOUNT	00779	85863-3
J4-8	600787	RECPTLE BOARD MOUNT	00779	85863-3
J4-9	600787	RECPTLE BOARD MOUNT	00779	85863-3
J4-10	600787	RECPTLE BOARD MOUNT	00779	85863-3
J4-11	600787	RECPTLE BOARD MOUNT	00779	85863-3
J4-12	600149	RECPTLE BLUE	74970	105-760
J4-13	600787	RECPTLE BOARD MOUNT	00779	85863-3
J4-14	600787	RECPTLE BOARD MOUNT	00779	85863-3
J4-15	600787	RECPTLE BOARD MOUNT	00779	85863-3
J4-16	600149	RECPTLE BLUE	74970	105-760
J17	600610	RECPTLE PCB MOUNT, RF TYPE	98291	500-5300-00
J18	600610	RECPTLE PCB MOUNT, RF TYPE	98291	500-5300-00
K1	310125	RELAY FORM A		E5A1H
K2	310127	RELAY FORM C	15636	RA3032-1051
K3	310127	RELAY FORM C	15636	RA3032-1051
K4	310127	RELAY FORM C	15636	RA3032-1051
K5	310127	RELAY FORM C	15636	RA3032-1051
K6	310127	RELAY FORM C	15636	RA3032-1051
L1	310068	CHOKE RF 1 μH 10%	99800	1537-12
L2	310068	CHOKE RF 1 μH 10%	99800	1537-12
L3	310126	CHOKE .39 μH 10%	24226	10/390μH±10%
L4	310068	CHOKE RF 1 μH 10%	99800	1537-12
L5	310126	CHOKE .39 μH 10%	24226	10/390μH±10%

*Quantity Required

406765 – Assy., SIGNAL CONDITIONER "A" *continued*

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
Q1	200241	TRANS	FET				17856	E420
Q2	200219	TRANS	Matched Pair		2N3563		21793	200219
Q3	200219	TRANS	Matched Pair		2N3563		21793	200219
R1	000430	RES	CARBON	43 OHM		5% 1/4W	81349	RC07GF430J
R3	010991	RES	METAL	990 K		.1%	81349	RN65C9903B
R4	010988	RES	METAL	10.1 K		.1%	81349	RN55C1012B
R5	010990	RES	METAL	900 K		.1%	81349	RN65C9003B
R6	010989	RES	METAL	111 K		.1%	81349	RN55C1113B
R7	010879	RES	METAL	1 M		1%	81349	RN55D
R8	000434	RES	CARBON	430 K		5% 1/4W	81349	RC07GF434J
R9	000121	RES	CARBON	120 OHM		5% 1/4W	81349	RC07GF121J
R10	000301	RES	CARBON	300 OHM		5% 1/4W	81349	RC07GF301J
R11	000132	RES	CARBON	1.3 K		5% 1/4W	81349	RC07GF132J
R12	010705	RES	METAL	4.53 K	T-0	1% 1/10W	81349	RN55D4531F
R13	000511	RES	CARBON	510 OHM		5% 1/4W	81349	RC07GF511J
R14	000121	RES	CARBON	120 OHM		5% 1/4W	81349	RC07GF121J
R15	010705	RES	METAL	4.53 K	T-0	1% 1/10W	81349	RN55D4531F
R16	000910	RES	CARBON	91 OHM		5% 1/4W	81349	RC07GF910J
R17	000430	RES	CARBON	43 OHM		5% 1/4W	81349	RC07GF430J
R18	000102	RES	CARBON	1 K		5% 1/4W	81349	RC07GF102J
R19	000511	RES	CARBON	510 OHM		5% 1/4W	81349	RC07GF511J
R20	000102	RES	CARBON	1 K		5% 1/4W	81349	RC07GF102J
R21	000121	RES	CARBON	120 OHM		5% 1/4W	81349	RC07GF121J
R22	000430	RES	CARBON	43 OHM		5% 1/4W	81349	RC07GF430J
R23	000102	RES	CARBON	1 K		5% 1/4W	81349	RC07GF102J
R24	000121	RES	CARBON	120 OHM		5% 1/4W	81349	RC07GF121J
R25	000121	RES	CARBON	120 OHM		5% 1/4W	81349	RC07GF121J
R26	000132	RES	CARBON	1.3 K		5% 1/4W	81349	RC07GF132J
R27	000102	RES	CARBON	1 K		5% 1/4W	81349	RC07GF102J
R28	000511	RES	CARBON	510 OHM		5% 1/4W	81349	RC07GF511J
R29	000910	RES	CARBON	91 OHM		5% 1/4W	81349	RC07GF910J
R30	000430	RES	CARBON	43 OHM		5% 1/4W	81349	RC07GF430J
R31	000121	RES	CARBON	120 OHM		5% 1/4W	81349	RC07GF121J
R32	010705	RES	METAL	4.53 K	T-0	1% 1/10W	81349	RN55D4531F
R33	000511	RES	CARBON	510 OHM		5% 1/4W	81349	RC07GF511J
R34	010705	RES	METAL	4.53 K	T-0	1% 1/10W	81349	RN55D4531F
R35	000301	RES	CARBON	300 OHM		5% 1/4W	81349	RC07GF301J
R36	000301	RES	CARBON	300 OHM		5% 1/4W	81349	RC07GF301J
R37	000102	RES	CARBON	1 K		5% 1/4W	81349	RC07GF102J
R38	000102	RES	CARBON	1 K		5% 1/4W	81349	RC07GF102J
R39	000302	RES	CARBON	3 K		5% 1/4W	81349	RC07GF302J

406765 – Assy., SIGNAL CONDITIONER "A" *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
R40	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GF302J
R41	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GF302J
R42	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R43	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GF302J
R44	000203	RES CARBON 20 K 5% 1/4W	81349	RC07GF203J
R45	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GF302J
R46	000242	RES CARBON 2.4 K 5% 1/4W	81349	RC07GF242J
R47	000511	RES CARBON 510 OHM 5% 1/4W	81349	RC07GF511J
R48	040229	POT CERMET 1 K 10%	73138	89P Series
R49	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GF302J
R50	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GF302J
R51	000301	RES CARBON 300 OHM 5% 1/4W	81349	RC07GF301J
R52	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GF302J
R53	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GF302J
R54	000301	RES CARBON 300 OHM 5% 1/4W	81349	RC07GF301J
R55	000301	RES CARBON 300 OHM 5% 1/4W	81349	RC07GF301J
R56	000301	RES CARBON 300 OHM 5% 1/4W	81349	RC07GF301J
R57	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R58	040228	POT CERMET 500 OHM 10%	73138	89PR500
R59	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
U1	230118	INTEGRATED CIRCUIT	86884	CA3086
U2	230118	INTEGRATED CIRCUIT	86884	CA3086
U3	230202	INTEGRATED CIRCUIT	86884	CA3102
U4	230028	INTEGRATED CIRCUIT CERAM	01295	SN7400N

406766 – Assy., SIGNAL CONDITIONER "B"

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
A1	406798	ASSY., CABLE, S/C, INTERCONNECT					21793	406798
C1	100063	CAP	CERAM	.01 MFD	500 V	20%	56289	5GAS-S10
C2	100079	CAP	CERAM	3.9 PFD	1000 V		56289	10TCCV39
C3	130146	CAP	VARIABLE	.25-1.5 PFD			74970	273-0001-002
C4	100119	CAP	CERAM	470 PFD	100 V		72982	8121-100-C0G0471J
C5	100085	CAP	CERAM	6.8 PFD	1000 V		56289	10TCCV68
C6	130146	CAP	VARIABLE	.25-1.5 PFD			74970	273-0001-002
C7	100102	CAP	CERAM	47 PFD	1000 V	5%	56289	C030B101F470J
C8	100120	CAP	CERAM	270 PFD	1000 V		56289	C023B102E271M
C9	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C10	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C11	110151	CAP	TANTA	10 MFD	35 V	20%	05397	T362C106M035A
C12	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C13	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C14	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C15	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C16	110151	CAP	TANTA	10 MFD	35 V	20%	05397	T362C106M035A
C17	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C18	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C19	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C20	110141	CAP	TANTA	22 MFD	15 V	20%	05397	T368B226M015AS
C21	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C22	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C23	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C24	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C25	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C26	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
CR1	211083	DIODE	SILICO		018		21793	211083
CR2	211083	DIODE	SILICO		018		21793	211083
CR3	211083	DIODE	SILICO		018		21793	211083
CR4	211083	DIODE	SILICO		018		21793	211083
CR5	211083	DIODE	SILICO		018		21793	211083
CR6	211083	DIODE	SILICO		018		21793	211083
CR7	211083	DIODE	SILICO		018		21793	211083
CR8	220031	DIODE	SILICO	ZENER	3.3 V		04713	1/4M3.3AZ5
CR9	220031	DIODE	SILICO	ZENER	3.3 V		04713	1/4M3.3AZ5
CR10	211236	DIODE	SILICO		007		21793	211236
CR11	211236	DIODE	SILICO		007		21793	211236
CR12	210064	DIODE	Matched Pair		018		21793	210064

406766 – Assy., SIGNAL CONDITIONER "B" *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
CR13	210064	DIODE Matched Pair 018	21793	210064
CR14	211083	DIODE SILICO 018	21793	211083
H1	600767	TERMINAL, TEFLON (2*)	98291	013-1400
H2	600786	POST (1*)	00779	1-87022-0
H13	610792	STANDOFF, SWG, THD, #2-56x .125 (3*)		
H14	610793	SPACER, SWG-ON, .438" LG (3*)		
H15	615019	SCREW, #2-56x5/8" LG (3*)		
H6	730681	SHIELD (2*)	21793	730681
H7	920734	SOCKET, IC, 14 PIN (4*)	71785	133-51-02-003
J3-1	600149	RECPTLE BLUE	74970	105-760
J3-2	600787	RECPTLE BOARD MOUNT	00779	85863-3
J3-3	600787	RECPTLE BOARD MOUNT	00779	85863-3
J3-4	600787	RECPTLE BOARD MOUNT	00779	85863-3
J3-5	600787	RECPTLE BOARD MOUNT	00779	85863-3
J3-6	600787	RECPTLE BOARD MOUNT	00779	85863-3
J3-7	600787	RECPTLE BOARD MOUNT	00779	85863-3
J3-8	600787	RECPTLE BOARD MOUNT	00779	85863-3
J3-9	600787	RECPTLE BOARD MOUNT	00779	85863-3
J3-10	600787	RECPTLE BOARD MOUNT	00779	85863-3
J3-11	600787	RECPTLE BOARD MOUNT	00779	85863-3
J3-12	600149	RECPTLE BLUE	74970	105-760
J3-13	600787	RECPTLE BOARD MOUNT	00779	85863-3
J3-14	600787	RECPTLE BOARD MOUNT	00779	85863-3
J3-15	600787	RECPTLE BOARD MOUNT	00779	85863-3
J3-16	600149	RECPTLE BLUE	74970	105-760
J19	600610	RECPTLE PCB MOUNT RF TYPE	98291	500-5300-00
K1	310125	RELAY FORM A		E5A1H
K2	310127	RELAY FORM C	15636	RA3032-1051
K3	310127	RELAY FORM C	15636	RA3032-1051
K4	310127	RELAY FORM C	15636	RA3032-1051
K5	310127	RELAY FORM C	15636	RA3032-1051
K6	310127	RELAY FORM C	15636	RA3032-1051
K7	310127	RELAY FORM C	15636	RA3032-1051
L1	310068	CHOKE RF 1 μH 10%	99800	1537-12
L2	310068	CHOKE RF 1 μH 10%	99800	1537-12

*Quantity Required

406766 — Assy., SIGNAL CONDITIONER "B" *continued*

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
L3	310126	CHOKE	RF	.39 μH		10%	24226	10/390μH±10%
L4	310068	CHOKE	RF	1 μH		10%	99800	1537-12
L5	310126	CHOKE	RF	.39 μH		10%	24226	10/390μH±10%
Q1	200241	TRANS	FET				17856	E420
Q2	200219	TRANS	Matched Pair		2N3563		21793	200219
Q3	200219	TRANS	Matched Pair		2N3563		21793	200219
R2	000430	RES	CARBON	43 OHM		5% 1/4W	81349	RC07GF430J
R3	010991	RES	METAL	990 K		.1%	81349	RN65C9903B
R4	010988	RES	METAL	10.1 K		.1%	81349	RN55C1012B
R5	010990	RES	METAL	900 K		.1%	81349	RN65C9003B
R6	010989	RES	METAL	111 K		.1%	81349	RN55C1113B
R7	010879	RES	METAL	1 M		1%	81349	RN55D
R8	000434	RES	CARBON	430 K		5% 1/4W	81349	RC07GF434J
R9	000121	RES	CARBON	120 OHM		5% 1/4W	81349	RC07GF121J
R10	000301	RES	CARBON	300 OHM		5% 1/4W	81349	RC07GF301J
R11	000132	RES	CARBON	1.3 K		5% 1/4W	81349	RC07GF132J
R12	010705	RES	METAL	4.53 K	T-0	1% 1/10W	81349	RN55D4531F
R13	000511	RES	CARBON	510 OHM		5% 1/4W	81349	RC07GF511J
R14	000121	RES	CARBON	120 OHM		5% 1/4W	81349	RC07GF121J
R15	010705	RES	METAL	4.53 K	T-0	1% 1/10W	81349	RN55D4531F
R16	000910	RES	CARBON	91 OHM		5% 1/4W	81349	RC07GF910J
R17	000430	RES	CARBON	43 OHM		5% 1/4W	81349	RC07GF430J
R18	000102	RES	CARBON	1 K		5% 1/4W	81349	RC07GF102J
R19	000511	RES	CARBON	510 OHM		5% 1/4W	81349	RC07GF511J
R20	000102	RES	CARBON	1 K		5% 1/4W	81349	RC07GF102J
R21	000121	RES	CARBON	120 OHM		5% 1/4W	81349	RC07GF121J
R22	000430	RES	CARBON	43 OHM		5% 1/4W	81349	RC07GF430J
R23	000102	RES	CARBON	1 K		5% 1/4W	81349	RC07GF102J
R24	000121	RES	CARBON	120 OHM		5% 1/4W	81349	RC07GF121J
R25	000121	RES	CARBON	120 OHM		5% 1/4W	81349	RC07GF121J
R26	000132	RES	CARBON	1.3 K		5% 1/4W	81349	RC07GF132J
R27	000102	RES	CARBON	1 K		5% 1/4W	81349	RC07GF102J
R28	000511	RES	CARBON	510 OHM		5% 1/4W	81349	RC07GF511J
R29	000910	RES	CARBON	91 OHM		5% 1/4W	81349	RC07GF910J
R30	000430	RES	CARBON	43 OHM		5% 1/4W	81349	RC07GF430J
R31	000121	RES	CARBON	120 OHM		5% 1/4W	81349	RC07GF121J
R32	010705	RES	METAL	4.53 K	T-0	1% 1/10W	81349	RN55D4531F
R33	000511	RES	CARBON	510 OHM		5% 1/4W	81349	RC07GF511J
R34	010705	RES	METAL	4.53 K	T-0	1% 1/10W	81349	RN55D4531F
R35	000301	RES	CARBON	300 OHM		5% 1/4W	81349	RC07GF301J

406766 – Assy., SIGNAL CONDITIONER "B" *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
R36	000301	RES CARBON 300 OHM 5% 1/4W	81349	RC07GF301J
R37	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R38	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R39	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GG302J
R40	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GF302J
R41	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GF302J
R42	000202	RES CARBON 2 K 5% 1/4W	81349	RC07GF202J
R43	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GF302J
R44	000203	RES CARBON 20 K 5% 1/4W	81349	RC07GF203J
R45	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GF302J
R46	000242	RES CARBON 2.4 K 5% 1/4W	81349	RC07GF242J
R47	000511	RES CARBON 510 OHM 5% 1/4W	81349	RC07GF511J
R48	040229	POT CERMET 1 K 10%	73138	89P Series
R49	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GF302J
R50	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GF302J
R51	000301	RES CARBON 300 OHM 5% 1/4W	81349	RC07GF301J
R52	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GF302J
R53	000302	RES CARBON 3 K 5% 1/4W	81349	RC07GF302J
R54	000301	RES CARBON 300 OHM 5% 1/4W	81349	RC07GF301J
R55	000301	RES CARBON 300 OHM 5% 1/4W	81349	RC07GF301J
R56	000301	RES CARBON 300 OHM 5% 1/4W	81349	RC07GF301J
R57	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R58	040228	POT CERMET 500 OHM 10%	73138	89PR500
R59	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
U1	230118	INTEGRATED CIRCUIT	86884	CA3086
U2	230118	INTEGRATED CIRCUIT	86884	CA3086
U3	230202	INTEGRATED CIRCUIT	86884	CA3102
U4	230028	INTEGRATED CIRCUIT CERAM	01295	SN7400N

406793 – Assy., PCB, 512 MHz PRESCALER

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
B1	406466	ASSY	BEAD				21793	406466
B2	406466	ASSY	BEAD				21793	406466
B3	406466	ASSY	BEAD				21793	406466
B4	406466	ASSY	BEAD				21793	406466
C1	100062	CAP	CERAM	.01 MFD	100 V	10%	72982	8121-100-W5R0-103K
C2	100062	CAP	CERAM	.01 MFD	100 V	10%	72982	8121-100-W5R0-103K
C3	100062	CAP	CERAM	.01 MFD	100 V	10%	72982	8121-100-W5R0-103K
C4	100062	CAP	CERAM	.01 MFD	100 V	10%	72982	8121-100-W5R0-103K
C5	100062	CAP	CERAM	.01 MFD	100 V	10%	72982	8121-100-W5R0-103K
C6	100062	CAP	CERAM	.01 MFD	100 V	10%	72982	8121-100-W5R0-103K
C7	110151	CAP	TANTA	10 MFD	35 V	20%	05397	T362C106M035A
C8	100062	CAP	CERAM	.01 MFD	100 V	10%	72982	8121-100-W5R0-103K
C9	100062	CAP	CERAM	.01 MFD	100 V	10%	72982	8121-100-W5R0-103K
C10	100062	CAP	CERAM	.01 MFD	100 V	10%	72982	8121-100-W5R0-103K
C11	110151	CAP	TANTA	10 MFD	35 V	20%	05397	T362C106M035A
C12	100071	CAP	CERAM	.001 MFD	1000 V	20%	56289	5GA-D10
C13	100062	CAP	CERAM	.01 MFD	100 V	10%	72982	8121-100-W5R0-103K
C14	100062	CAP	CERAM	.01 MFD	100 V	10%	72982	8121-100-W5R0-103K
C15	100062	CAP	CERAM	.01 MFD	100 V	10%	72982	8121-100-W5R0-103K
C16	100062	CAP	CERAM	.01 MFD	100 V	10%	72982	8121-100-W5R0-103K
C17	100071	CAP	CERAM	.001 MFD	1000 V	20%	56289	5GA-D10
C18	100062	CAP	CERAM	.01 MFD	100 V	10%	72982	8121-100-W5R0-103K
C19	100062	CAP	CERAM	.01 MFD	100 V	10%	72982	8121-100-W5R0-103K
C20	100062	CAP	CERAM	.01 MFD	100 V	10%	72982	8121-100-W5R0-103K
C21	100025	CAP	CERAM	.005 MFD	100 V	20%	72982	835-000-X5V0502Z
C22	130103	CAP	CERAM	.01 MFD	25 V	20%	72982	9ACF-W5R103M
C23	130103	CAP	CERAM	.01 MFD	25 V	20%	72982	9ACF-W5R103M
C24	110151	CAP	TANTA	10 MFD	35 V	20%	05397	T362C106M035A
C25	130103	CAP	CERAM	.01 MFD	25 V	20%	72982	9ACF-W5R103M
C26	110151	CAP	TANTA	10 MFD	35 V	20%	05397	T362C106M035A
C27	130103	CAP	CERAM	.01 MFD	25 V	20%	72982	9ACF-W5R103M
C28	100062	CAP	CERAM	.01 MFD	100 V	10%	72982	8121-100-W5R0-103K
C29	100062	CAP	CERAM	.01 MFD	100 V	10%	72982	8121-100-W5R0-103K
C30	110151	CAP	TANTA	10 MFD	35 V	20%	05397	T362C106M035A
C31	110151	CAP	TANTA	10 MFD	35 V	20%	05397	T362C106M035A
C32	100062	CAP	CERAM	.01 MFD	100 V	10%	72982	8121-100-W5R0-103K
C33	110151	CAP	TANTA	10 MFD	35 V	20%	05397	T362C106M035A
C34	100062	CAP	CERAM	.01 MFD	100 V	10%	72982	8121-100-W5R0-103K
C35	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C36	130103	CAP	CERAM	.01 MFD	25 V	20%	72982	9ACF-W5R103M
C37	110151	CAP	TANTA	10 MFD	35 V	20%	05397	T362C106M035A

406793 -- Assy., PCB, 512 MHz PRESCALER *continued*

REF DES	DANA P/N	DESCRIPTION					FSC	MANU P/N
C38	130103	CAP	CERAM	.01 MFD	25 V	20%	72982	9ACF-W5R103M
C39	130103	CAP	CERAM	.01 MFD	25 V	20%	72982	9ACF-W5R103M
C40	100062	CAP	CERAM	.01 MFD	100 V	10%	72982	8121-100-W5R0-103
C41	130103	CAP	CERAM	.01 MFD	25 V	20%	72982	9ACF-W5R103M
C42	100062	CAP	CERAM	.01 MFD	100 V	10%	72982	8121-100-W5R0-103
C43	100062	CAP	CERAM	.01 MFD	100 V	10%	72982	8121-100-W5R0-103
C44	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C45	100062	CAP	CERAM	.01 MFD	100 V	10%	72982	8121-100-W5R0-103
C46	110151	CAP	TANTA	10 MFD	35 V	20%	05397	T362C106M035A
C47	100062	CAP	CERAM	.01 MFD	100 V	10%	72982	8121-100-W5R0-103
C48	110151	CAP	TANTA	10 MFD	35 V	20%	05397	T362C106M035A
C49	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C50	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C51	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C52	110151	CAP	TANTA	10 MFD	35 V	20%	05397	T362C106M035A
C53	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C54	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C55	110151	CAP	TANTA	10 MFD	35 V	20%	05397	T362C106M035A
C56	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C57	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C58	110151	CAP	TANTA	10 MFD	35 V	20%	05397	T362C106M035A
C59	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
C60	100017	CAP	CERAM	.01 MFD	100 V	20%	56289	TG-S10
CR1	210022	DIODE					50434	HP5082-3080
CR2	210022	DIODE					50434	HP5082-3080
CR3	210022	DIODE					50434	HP5082-3080
CR4	210004	DIODE	SILICO				81349	1N4004
CR5	210022	DIODE					50434	HP5082-3080
CR6	210022	DIODE					50434	HP5082-3080
CR7	211083	DIODE	SILICO		018		21793	211083
CR8	211083	DIODE	SILICO		018		21793	211083
CR9	210026	DIODE	RF				81349	1N82AG
CR10	210026	DIODE	RF				81349	1N82AG
F1	920054	FUSE		1/10 AMP			71400	BMW1/10
H1	600834	SOCKET, 14 PIN (1*)					00779	50477-7
H2	920006	TRANSIPAD (Ref: Q1, Q2) (2*)					21793	920006
H3	920419	SOCKET, 16 PIN (1*)						CA-16S-TSD-E
H4	920482	SOCKET, 8 PIN (1*)					71785	8ICS

*Quantity Required

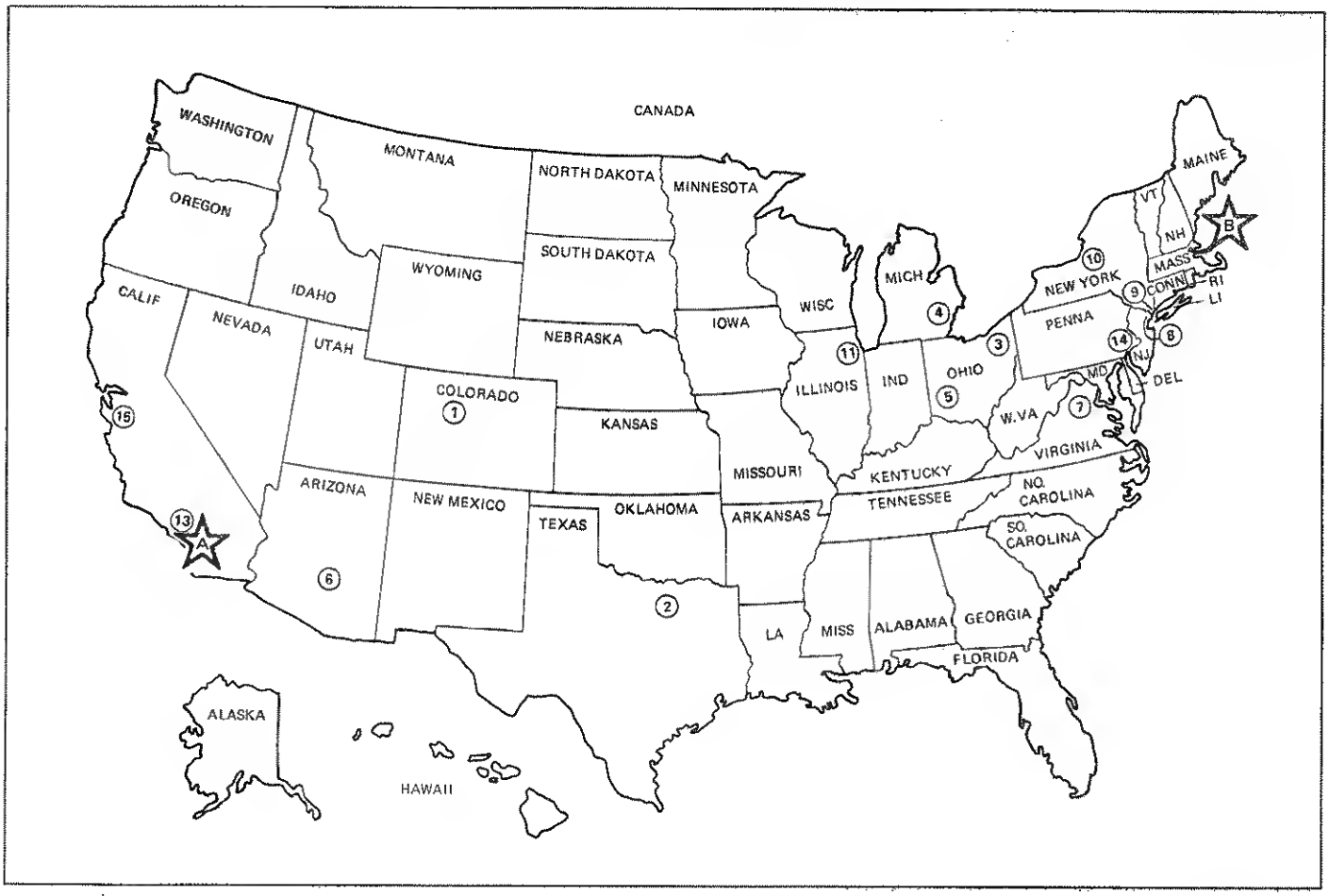
406793 – Assy., PCB, 512 MHz PRESCALER *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
J1-1	600149	RECPTLE BLUE	74970	105-760
J1-2	600787	RECPTLE BOARD MOUNT	00779	85863-3
J3	600149	RECPTLE BLUE	74970	105-760
J4	600787	RECPTLE BOARD MOUNT	00779	85863-3
J5	600787	RECPTLE BOARD MOUNT	00779	85863-3
J6	600787	RECPTLE BOARD MOUNT	00779	85863-3
J7	600787	RECPTLE BOARD MOUNT	00779	85863-3
J8	600787	RECPTLE BOARD MOUNT	00779	85863-3
J9	600787	RECPTLE BOARD MOUNT	00779	85863-3
J10	600149	RECPTLE BLUE	74970	105-760
J20	600610	CONN RF	98291	50-053-0000
L1	310062	CHOKE RF 22 µH	99800	1537-44
L2	310062	CHOKE RF 22 µH	99800	1537-44
L3	310062	CHOKE RF 22 µH	99800	1537-44
L4	310062	CHOKE RF 22 µH	99800	1537-44
L5	310062	CHOKE RF 22 µH	99800	1537-44
L6	310062	CHOKE RF 22 µH	99800	1537-44
L7	310062	CHOKE RF 22 µH	99800	1537-44
Q1	200035	TRANS SILICO NPN 014	21793	200035
Q2	200011	TRANS SILICO PNP 009	21793	200011
Q3	200200	TRANS NPN	21793	200200
Q4	200200	TRANS NPN	21793	200200
Q5	200200	TRANS NPN	21793	200200
Q6	200088	TRANS SILICO PNP	80131	2N4248
Q7	200200	TRANS NPN	21793	200200
R1	000510	RES CARBON 51 OHM 5% 1/4W	81349	RC07GF510J
R2	001683	RES CARBON 47 OHM 5% 1/2W	81349	RC20GF470J
R3	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
R4	000510	RES CARBON 51 OHM 5% 1/4W	81349	RC07GF510J
R5	001812	RES CARBON 270 OHM 5% 1/2W	01121	See Descrpt.
R6	000121	RES CARBON 120 OHM 5% 1/4W	81349	RC07GF121J
R7	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
R8	000510	RES CARBON 51 OHM 5% 1/4W	81349	RC07GF510J
R9	000510	RES CARBON 51 OHM 5% 1/4W	81349	RC07GF510J
R10	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
R11	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
R12	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
R13	000510	RES CARBON 51 OHM 5% 1/4W	81349	RC07GF510J
R14	000510	RES CARBON 51 OHM 5% 1/4W	81349	RC07GF510J

406793 — Assy., PCB, 512 MHz PRESCALER *continued*

REF DES	DANA P/N	DESCRIPTION	FSC	MANU P/N
R15	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R16	000101	RES CARBON 100 OHM 5% 1/4W	81349	RC07GF101J
R17	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R18	000152	RES CARBON 1.5 K 5% 1/4W	81349	RC07GF152J
R19	040261	POT CERMET 2 K 20% .5 W	73138	72XW
R20	000222	RES CARBON 2.2 K 5% 1/4W	81349	RC07GF222J
R21	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R22	000123	RES CARBON 12 K 5% 1/4W	81349	RC07GF123J
R23	000121	RES CARBON 120 OHM 5% 1/4W	81349	RC07GF121J
R24	000183	RES CARBON 18 K 5% 1/4W	81349	RC07GF183J
R25	000222	RES CARBON 2.2 K 5% 1/4W	81349	RC07GF222J
R26	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
R27	000512	RES CARBON 5.1 K 5% 1/4W	81349	RC07GF512J
R28	000683	RES CARBON 68 K 5% 1/4W	81349	RC07GF683J
R29	000222	RES CARBON 2.2 K 5% 1/4W	81349	RC07GF222J
R30	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
R31	040265	POT CERMET 50 K 20% .5 W	73138	72XW
R32	000751	RES CARBON 750 OHM 5% 1/4W	81349	RC07GF751J
R33	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
R34	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
R35	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R36	000102	RES CARBON 1 K 5% 1/4W	81349	RC07GF102J
R37	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
R38	000100	RES CARBON 10 OHM 5% 1/4W	81349	RC07GF100J
R39	000153	RES CARBON 15 K 5% 1/4W	81349	RC07GF153J
R40	000152	RES CARBON 1.5 K 5% 1/4W	81349	RC07GF152J
R41	000682	RES CARBON 6.8 K 5% 1/4W	81349	RC07GF682J
R42	000241	RES CARBON 240 OHM 5% 1/4W	81349	RC07GF241J
R43	000511	RES CARBON 510 OHM 5% 1/4W	81349	RC07GF511J
TP1	600786	TEST POINT	00779	1-87022-0
TP2	600786	TEST POINT	00779	1-87022-0
U1	230119	INTEGRATED CIRCUIT	07263	μA741
U2	230273	INTEGRATED CIRCUIT		SP8630B
U3	230205	INTEGRATED CIRCUIT	04713	10102P
U4	230183	INTEGRATED CIRCUIT	73445	ATF419
U5	230182	INTEGRATED CIRCUIT	73445	ATF417

U.S. AND CANADIAN SERVICE CENTERS



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A DANA LABORATORIES, INC.
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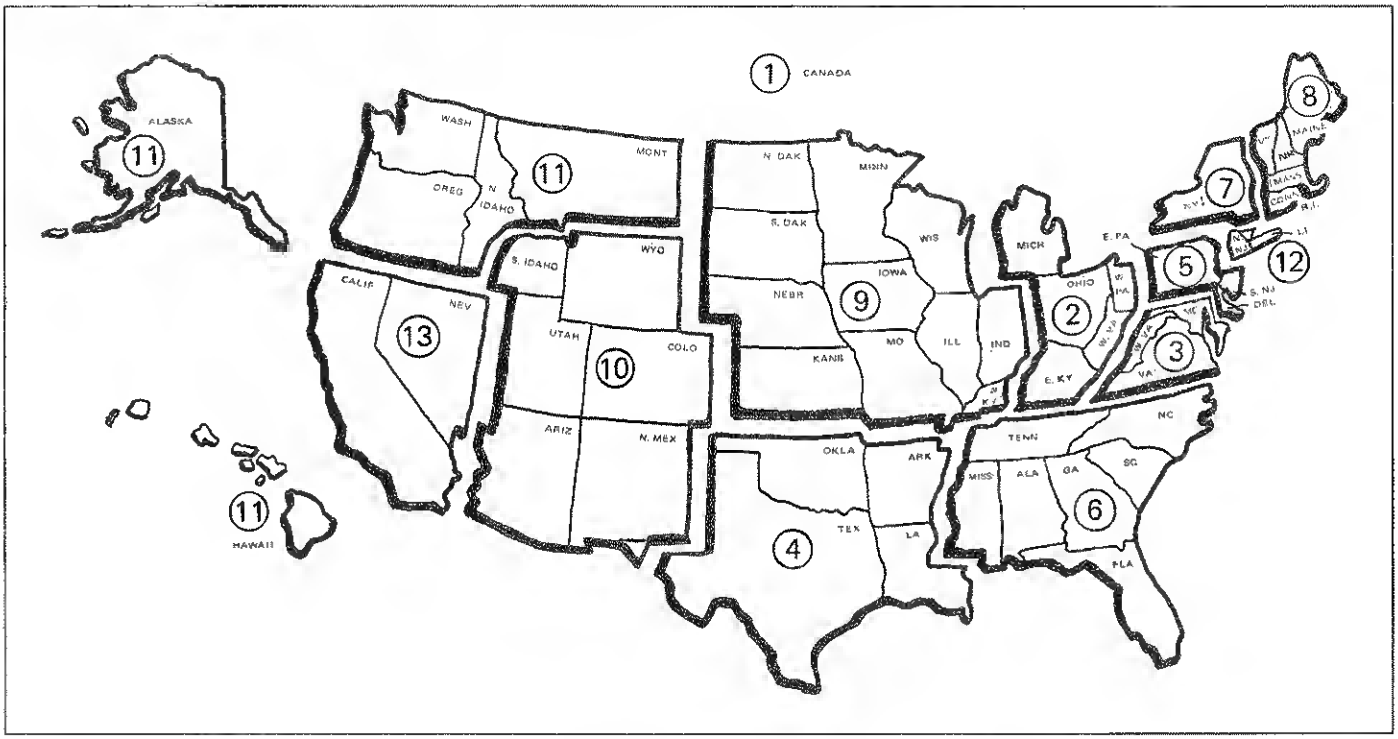

1 ASSOCIATED TEST EQUIPMENT LTD.

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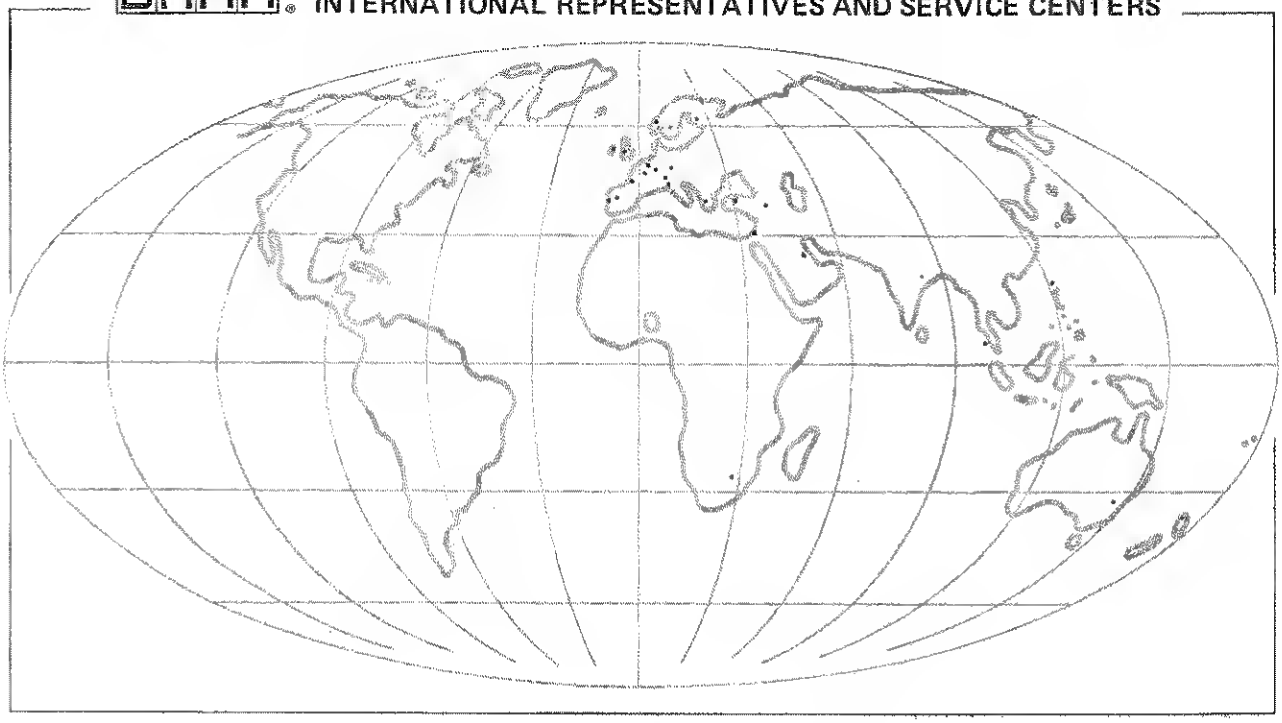

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